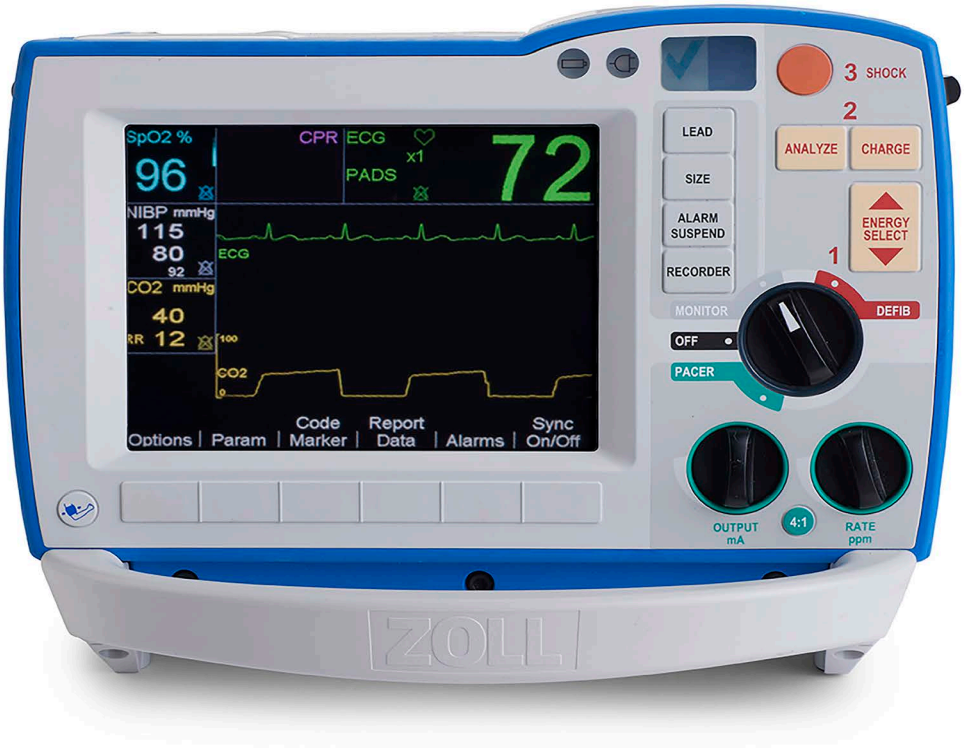
R Series®
Service Manual



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ZOLL®

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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

This service manual is intended for the service technician whose responsibility is to maintain and inspect ZOLL R Series defibrillators. The manual has six main sections and one appendix.

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 R Series unit.

Chapter 1—Maintenance Tests explains how to check the performance of the R Series unit using a series of recommended checkout procedures to be conducted annually.

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

Chapter 3—Disassembly Procedures describes step by step procedures for removing assemblies and sub-assemblies from the R Series unit.

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

Chapter 5—Functional Description provides technical descriptions of the major subassembly modules and technologies found within the R Series unit.

Chapter 6—Test After Repair provides information on what tests need to be performed after repairing or replacing components in the device.

Appendix A—Contains miscellaneous reference information, such as the R Series interconnect diagram and a table containing the expected output for delivered energy loads.

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 R 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 R Series unit.

WARNING! The R Series unit can generate up to 2,850 volts with sufficient current to cause lethal shocks.

All persons near the equipment must be warned to *STAND CLEA*R prior to discharging the defibrillator.

Do not discharge the unit's internal 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™ Battery Charger Station.

Do not use the R 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 are several other components to the ZOLL R Series documentation. These components include:

- *ZOLL R Series Operator's Guide* - describes all the user tasks needed to operate the R Series.
- *ZOLL R Series Configuration Guide* - describes the R Series features and functions whose operation can be customized by authorized users.
- *ZOLL R Series Operator's Guide - Pulse Oximetry (SpO_2) Insert* - describes all the user tasks needed to operate the R Series Pulse Oximetry option.
- *ZOLL R Series Operator's Guide - Non-Invasive Blood Pressure (NIBP) Insert* - describes all the user tasks needed to operate the R Series NIBP option.
- *ZOLL R Series Operator's Guide - End Tidal Carbon Dioxide ($EtCO_2$) Insert* - describes all the user tasks needed to operate the R Series $EtCO_2$ option.

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 contextual information.

Service Policy Warranty

In North America: Consult your purchasing agreement for terms and conditions associated with your warranty. Outside of North America, consult 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 R Series unit requires service, contact the ZOLL Technical Service Department:

Telephone: 1(800)348-9011 (USA), 1(866)442-1011 (Canada)

Email: techsupport@zoll.com

Prior to calling, please have the following information available for the Technical Service representative:

- Unit serial number
- Description of the problem
- Name of department where equipment is used
- Purchase Order to allow tracking of loan equipment
- Purchase Order for a unit with an expired warranty
- Sample chart recorder strips documenting the problem, if applicable
- Full disclosure file from the unit, if applicable (.FUL extension)
- Ready code file from the unit, if applicable (.DCK extension)
- Activity log file from the unit, if applicable (.RAL extension)

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# XXXXXX

Phone: 1(800)348-9011, Fax: 978-421-0010

Technical Service Outside of the United States

Customers outside of the United States 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 ZOLL International Technical Support Department.

International Technical Support

Phone: 1(978)421-9460

Email: intlservice@zoll.com

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

Overview

A qualified biomedical technician must perform a more thorough maintenance test checkout every 12 months to ensure that the functions of the R Series unit work properly. This checkout procedure is often referred to as “Preventive Maintenance” and “Annual Inspection” procedures. This chapter describes the step by step procedures for performing this procedure.

Because the R Series units must be maintained ready for immediate use, regular readiness testing is required. It can either be performed manually or automatically. Refer to the *R Series Operator’s Guide* for details (REF 9650-0904-01 (BLS devices), REF 9650-0912-01 (ALS devices)).

For your convenience, a standalone checklist tool exists which can be used to record the results of the maintenance test procedures (“ZOLL R Series Annual Inspection Checklist”, **REF** 5000-000903-FM). This checklist can be found by visiting *https://www.zoll.com/RSeriesInspection* or by scanning the QR code below with your mobile device. **Note the maintenance test procedures in this service manual align with Rev. B of the checklist.**

R Series Annual Inspection Checklist

This chapter contains step by step instructions on performing the following maintenance tests:

1.0 Physical Inspection of Unit

2.0 Ready for Use Test

3.0 Front Panel Button Test

4.0 ECG Test

5.0 Print Calibration Test

6.0 Notch Filter Test

7.0 Shock Test

8.0 Synchronized Cardioversion Test

9.0 Remote Cardioversion Test (optional)

10.0 Pacer Output Test

11.0 Synchronized Pacing Test

12.0 SpO2 Function Check (if applicable)

13.0 EtCO2 Functional Test (if applicable)

14.0 CO2 Accuracy Check (if applicable)

15.0 Paddles Test (if applicable)

16.0 NIBP Leak Test (if applicable)

17.0 NIBP Calibration Test (if applicable)

18.0 Leakage Current Test

19.0 CPR Feedback Test (if applicable)

20.0 Wi-Fi Card Functionality Test (optional)

Before You Begin the Maintenance Tests

- Assemble the tools or specialized testing equipment listed in the “Equipment You Need to Perform the Maintenance Tests” section shown below.
- Keep an extra fully charged ZOLL SurePower™ defibrillator battery available.
- Photocopy the checklist at the back of this document and use the copy to record your results. As you conduct each step of a procedure, mark the Pass/Fail/NA check boxes on your checklist and then keep it for your maintenance records.
- 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.

Equipment You Need to Perform the Maintenance Tests

This section lists the equipment used to perform the maintenance tests described in this chapter. You can substitute an equivalent device for a listed device; however, please note that not all simulators and analyzers will produce the same results. Be sure to follow the manufacturer's recommendations for the specific simulator/analyzer you're using.

ZOLL recommends the use of the following equipment when performing Maintenance Tests:

- MFC to Analyzer Adapter (ZOLL PN: 9100-3039-TF)
- Defibrillator analyzer (Fluke Impulse 7000DP or equivalent)
- Electrical Safety analyzer
- SpO_2 cable and sensor (if option is installed)
- NIBP simulator/analyzer (Fluke ProSim 8 or equivalent)
- CAPNOSTAT 5 Mainstream cable with airway adapter (if $EtCO_2$ option is installed)
- Stopwatch
- Paddles
- R Series printer paper (AKA recorder paper) (ZOLL PN: 8000-000877-01)
- Battery
- AC line cord
- 3-lead adapter (PN: 8009-0762-XX) or 3-lead ECG cable, and 5-lead ECG cable
- Gas regulator (if $EtCO_2$ option is installed)
- Calibration gas (if $EtCO_2$ option is installed)(AirGas P/N: Z03NI748PDC004)
- OneStep Training Cable (ZOLL PN: 8900-0180) (for CPR Test Option 1)
- OneStep to CPR-D Adapter (ZOLL PN: 8009-0020) and
  ZOLL AED Simulator (ZOLL PN: 8000-000925) (for CPR Test Option 2)

Note: Calibration gas can be ordered from AirGas/Air Liquide by referencing the above part number. If sourcing calibration gas from another supplier, ensure the gas is medical grade and contains a composition of 5% CO_2, 21% O_2 Balance N_2.

1.0 Physical Inspection of Unit

Equipment None

Test Setup Ensure the R Series is connected to AC power and that a fully charged battery is installed.

		Procedure	Pass/Fail/NA
MAIN HOUSING	1.1	Inspect the device to ensure it is clean and without any obvious signs of damage, loose housing parts, cracks or excessive wear.	o o
	1.2	Inspect the printer door to ensure it can open and close properly.	o o
	1.3	Remove all accessories and ensure that the input connectors are clean and undamaged.	o o
CONTROL DIALS	1.4	Ensure the main control knob can easily rotate and switch into all available modes of operation.	o o
	1.5	Ensure the pacer “OUTPUT” dial is able to rotate freely in both directions.	o o
	1.6	Ensure the pacer “RATE” dial is able to rotate freely in both directions.	o o
PADDLES	1.7	Ensure the adult shoes slide on and off easily to expose the pediatric plates.	o o o
	1.8	Ensure the paddle plates do not show any deep scratches or signs of damage.	o o o
	1.9	Ensure the paddles are clean and free of any paddle gel.	o o o
	1.10	Ensure the OneStep cable cannot be inserted into the paddles with reversed polarity (upside down).	o o o
CABLES	1.11	Inspect all cables (including accessories) and ensure there are no cuts, cracks, or exposed wires present.	o o
BATTERY/ POWER	1.12	Ensure the battery can be seated properly into the battery well.	o o
	1.13	Verify the AC power LED is illuminated as a solid green LED.	o o
	1.14	Verify the battery LED shows either a solid green or solid amber LED.	o o
Note:	If the battery LED is flashing, ensure the battery is properly seated into 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.		

2.0 Ready for Use Test

Equipment Battery, OneStep Multi-Function cable

Test Setup Ensure the R Series is connected to AC power and that a fully charged battery is installed. Power on the R Series into either “On” or “Defib” positions. Confirm “Manual” mode if required. Ensure the OneStep Multi-Function cable is connected to the R Series.

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.

Caution Do NOT internally discharge the unit more than 3 times in the span of 1 minute. Multiple rapid internal discharges at more than 30J may damage the unit.

	Procedure	Pass/Fail
2.1	Connect the OneStep cable to the right side panel test port. Verify “DEFIB PAD SHORT” appears on the display.	o o
2.2	Using the energy select and charge buttons, charge the device to 30 Joules.	
2.3	Verify that the charging tone sounds	o o
2.4	Press the SHOCK button and verify that the “**30J TEST OK**” message displays on the screen. **Note:** This message is displayed briefly.	o o
2.5	Verify a green check mark appears in the Ready for Use Indicator (RFU) window.	o o
2.6	On the print out, verify the following values: **TEST_CUR=10–14A** and **DEFIB_IMPED = 0–5 Ohms.**	o o
Note: If the device shows a persistent red “X” in the RFU window, access the device test log to identify any recorded faults. This log can be accessed by turning the main control dial into either the “ON” or “Monitor” positions, then pressing Report Data > Test Log.		
2.7	Unplug the OneStep cable from the test port and verify that the “Check Pads” message appears on the display.	o o
2.8	Disconnect R Series from AC power.	
2.9	Remove the battery from the battery well. Verify that a red “X” appears in the RFU window.	o o
2.10	Replace the battery into the battery well. Verify the RFU window displays a green check mark.	o o

3.0 Front Panel Button Test

Equipment Defibrillator analyzer, ECG cable, OneStep Multi-Function cable

Test Setup

1. Ensure the R Series is connected to AC power and a fully charged battery is installed.
2. Power the R Series into either the “On” or “Defib” positions. Confirm “Manual” mode if required.
3. Connect both ECG cables and the OneStep cable to the analyzer. Enter the appropriate mode on the analyzer to receive defibrillation energy.

	Procedure	Pass/Fail
3.1	Press the “**LEAD**” button and verify that the selected ECG Lead changes. Press the button repeatedly until “PADS” displays.	o o
3.2	Press the “**SIZE**” button and verify that the ECG size value changes. Press the button repeatedly until “x1” is selected.	o o
3.3	Press the “**ALARM SUSPEND**” button and verify that the alarm bell state changes. If alarms begin to sound, press and hold the button for at least 4 seconds. Alarms will now be disabled.	o o
3.4	Press the “**RECORDER**” button, and verify that the recorder begins to print. You may press the button again to cancel printing.	o o
3.5	Press the “**ENERGY SELECT**” button once up, and once down. Verify energy selection increases and decreases.	o o
3.6	Press the “**CHARGE**” button and verify the R Series begins to charge.	o o
3.7	Verify the “**SHOCK**” button illuminates and then press it to discharge energy into the analyzer.	o o
3.8	Press the “**ANALYZE**” button and confirm an ECG analysis begins.	o o
3.9	Turn the main control knob down into “**PACER**” mode.	o o
3.10	Press and Hold the **4:1** button. Visually verify that the distance between stimulus markers widens on the display while the button is held.	o o
3.11	Rotate the **OUTPUT** and **RATE** dials. Verify that the **mA** and **PPM** values change correspondingly.	o o
3.12	(If Applicable) Press the **NIBP** button and confirm the NIBP system begins to inflate. You may press the NIBP button a second time to cancel the reading.	o o

4.0 ECG Test

Equipment ECG Simulator, ECG cable

Test Setup

1. Power the R Series into “On” or “Monitor” position. Confirm “Manual” mode is required.
2. Connect ECG Leads to the simulator. The simulator should be operating on battery power if possible.
3. Press the “LEAD” button on the R Series and select ECG Lead II.
4. Ensure that the alarms are enabled and activated on the device.

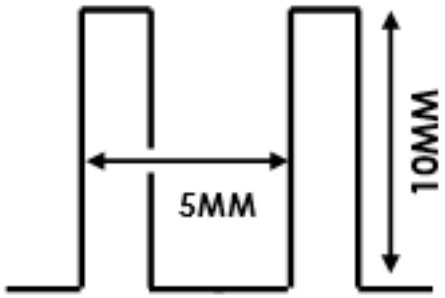
	Procedure	Pass/Fail
4.1	Simulate a Normal Sinus Rhythm at 60 BPM.	
4.2	Verify the ECG signal appears on the display.	o o
4.3	Verify the HR is between 59–61 BPM.	o o
4.4	Disconnect a single lead from the simulator and verify the “ECG LEAD OFF” message displays within 3 seconds.	o o
4.5	Verify that the HR alarm sounds. You may press and hold the alarm suspend button for 4 seconds to permanently deactivate the alarm.	
4.6	Reconnect the ECG Lead, and then repeat these steps for the remaining leads. When each lead is removed, verify the “ECG LEAD OFF” message displays	
Note: If the “ECG LEAD OFF” message does not appear during this test, check the supervisor configuration, and ensure the setting under the ECG menu “Enable Leads Off” is set to “Yes”. Be sure to restore the original configuration setting after testing is complete.		

5.0 Print Calibration Test

Equipment R Series printer paper

Test Setup
1. Power on R Series into either the “On” or “Monitor” position. Confirm “Manual” mode if required.
2. Ensure paper is properly installed into the recorder tray.

	Procedure	Pass/Fail
5.1	Press and hold the “SIZE” button on the R Series to introduce a 1mV square wave at 300 per minute onto the display.	
5.2	Activate the recorder to print a strip. **Note:** The recorder prints on a 6 second delay.	
5.3	The strip chart displays a signal of 300 ppm with an amplitude of 10 mm +/- 1 mm. The signal also appears on the video display. (You can verify that the rate is 300ppm by measuring 5mm from the left edge of one pulse to the left edge of the following pulse.) See the illustration below for reference.	o o



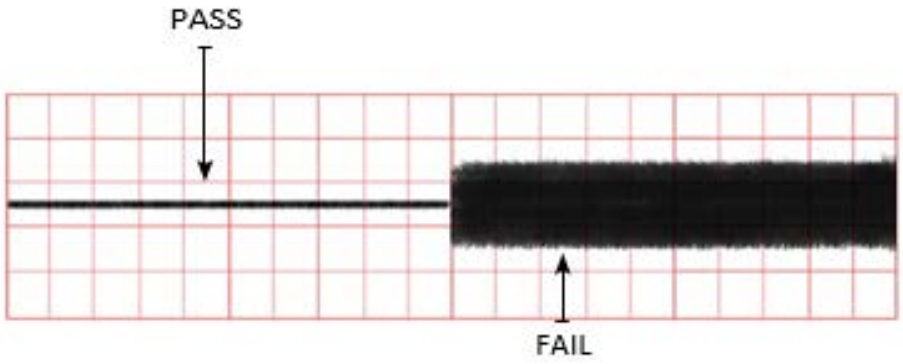
6.0 Notch Filter Test

Equipment Defibrillator analyzer, ECG cables

Test Setup

1. Connect ECG leads to analyzer and power on the R Series into either the “On” or “Monitor” positions. Confirm “Manual” mode if required.
2. Press the LEAD button on the R Series and select ECG Lead II. Press the SIZE button to select “x3”.
3. Enter the appropriate mode on the analyzer for simulating sine waves.

	Procedure	Pass/Fail/NA
6.1	Using the analyzer simulate either a 50Hz or 60Hz sine wave per your local AC Mains frequency and device configuration.	
6.2	Press the “**RECORDER**” button to print a 10 second strip.	
6.3	Verify the waveform amplitude on the strip chart is less than 1.5 mm (1.5 boxes on the graph paper).	o o o
6.4	Press the SIZE button to reset back to x1.	
Note: If the test fails, check the “Notch filter” setting under system configuration. Ensure the filter choice matches your local AC Mains frequency.		



7.0 Shock Test

Equipment Defibrillator analyzer, Multi-Function cable

Test Setup
1. Connect the R Series to the analyzer via Multi-Function cable or paddles.
2. Place the analyzer into the appropriate mode for displaying energy output.
3. Ensure the R Series is powered on into “Defib” mode for an ALS device or the mode selector is in the “ON” position for a BLS/Plus device. Confirm “Manual” mode if necessary.

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.

Caution Do NOT internally discharge the unit more than 3 times in the span of 1 minute. Multiple rapid internal discharges at more than 30J may damage the unit.

	Procedure	Pass/Fail
7.1	Charge and Shock according to the instructions below. Ensure joule output is within the expected tolerance range. A complete energy output chart can be found following this table. **Note:** Discharge values listed below are based on a 50 ohm test load.	o o
7.2	Using the **ENERGY SELECT** button, select 5 joules, then press the **CHARGE** button. Once the **SHOCK** button is illuminated, press the **SHOCK** button. Verify that the unit delivered 3–7J in the defibrillator analyzer	o o
7.3	Using the **ENERGY SELECT** button, select 50 joules, then press the **CHARGE** button. Once the **SHOCK** button is illuminated, press the **SHOCK** button. Verify that the unit delivered 46–62J in the defibrillator analyzer.	o o
7.4	Using the **ENERGY SELECT** button, select 100 joules, then press the **CHARGE** button. Once the **SHOCK** button is illuminated, press the **SHOCK** button. Verify that the unit delivered 93–125J in the defibrillator analyzer.	o o
7.5	Using the **ENERGY SELECT** button, select 200 joules, then press the **CHARGE** button. Once the **SHOCK** button is illuminated, press the **SHOCK** button. Verify that the unit delivered 196–264J in the defibrillator analyzer.	o o
7.6	At 200J verify that the patient current is between 23.9–25.9A. Defib Impedance is between 46–54 Ohms and charge time is between 1–7 Seconds. Perform this test once on battery power and once on AC Power.	o o

Selected Energy	Load							Accuracy*
	25 Ω	50 Ω	75 Ω	100 Ω	125 Ω	150 Ω	175 Ω	
1	1 J	1 J	1 J	1 J	1 J	1 J	1 J	3 J
2	1 J	2 J	2 J	2 J	2 J	2 J	2 J	
3	2 J	3 J	3 J	3 J	3 J	3 J	3 J	
4	3 J	4 J	4 J	5 J	5 J	5 J	4 J	
5	3 J	5 J	6 J	6 J	6 J	6 J	6 J	
6	4 J	6 J	7 J	7 J	7 J	7 J	7 J	
7	5 J	7 J	8 J	8 J	8 J	8 J	8 J	
8	5 J	8 J	9 J	9 J	10 J	9 J	9 J	
9	6 J	9 J	10 J	11 J	11 J	11 J	10 J	
10	7 J	10 J	12 J	12 J	12 J	12 J	12 J	
15	10 J	16 J	17 J	18 J	18 J	18 J	17 J	
20	14 J	21 J	23 J	24 J	24 J	24 J	23 J	
30	21 J	32 J	35 J	36 J	37 J	36 J	35 J	± 15%
50	35 J	54 J	59 J	61 J	62 J	61 J	59 J	
70	49 J	76 J	83 J	85 J	87 J	86 J	83 J	
75	53 J	81 J	89 J	91 J	93 J	92 J	89 J	
85	60 J	92 J	101 J	104 J	106 J	104 J	101 J	
100	71 J	109 J	119 J	122 J	125 J	123 J	119 J	
120	85 J	131 J	143 J	147 J	150 J	147 J	143 J	
150	107 J	164 J	180 J	183 J	188 J	184 J	179 J	
200	142 J	230 J	249 J	253 J	269 J	261 J	260 J	

*For all energy levels, accuracy is equal to either ±15% or 3 joules, whichever is greater.

Note: The ZOLL Rectilinear Biphasic Waveform (RBW) compensates for impedance measured between the electrodes. Delivered energy may be higher or lower than the selected energy based on the impedance. Accuracy is assessed based on delivered energy which is determined by energy selection and measured impedance.

As an example, if 200 joules is selected and then delivered into 50 Ohms, the expected output is 230 joules. The allowed 15% tolerance is then assessed from 230, not 200. Therefore, the acceptable range would be 196–264.

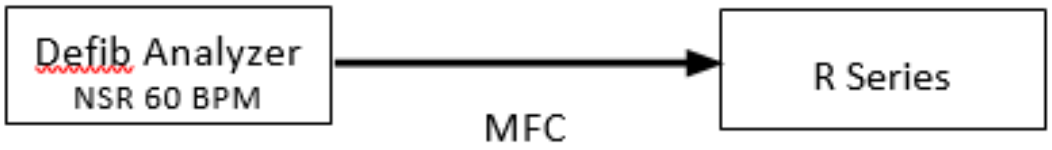
8.0 Synchronized Cardioversion Test

Equipment Defibrillator analyzer, Multi-Function cable

Test Setup

1. Connect the R Series to the analyzer via Multi-Function cable or paddles.
2. Place the analyzer into the appropriate mode for Synchronized Cardioversion.
3. Ensure the R Series is powered on into “Defib” mode for an ALS device or the mode selector is in the “ON” position for a BLS/Plus device. Confirm “Manual” mode if necessary.

	Procedure	Pass/Fail
8.1	On the analyzer simulate a Normal Sinus Rhythm at 60 BPM.	
8.2	On the R Series press the “**SYNC**” softkey to enable synchronized cardioversion.	
8.3	Verify that sync markers appear over each “R” wave in the ECG signal. The sync markers appear as a down arrow over each R Wave peak.	o o
8.4	Press the “**Charge**” button to charge the R Series to any Joule setting.	
8.5	When the shock button illuminates, press and hold the **SHOCK** button to deliver energy.	
8.6	On the analyzer, verify the sync delay is less than 60 ms.	o o



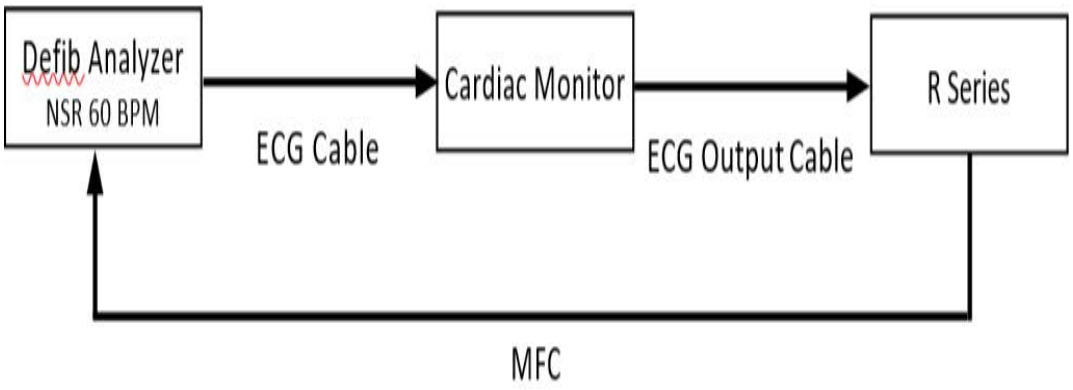
9.0 Remote Cardioversion Test (optional)

Note: This test measures signal delay between a bedside or cardiac monitor and the R Series. This test is only applicable if the device is being used in an area where the ECG signal is slaved from an external monitor.

Equipment Defibrillator analyzer, Multi-Function cable, Cardiac Monitor

Test Setup

1. Following the diagram below, connect the cardiac monitor between the R Series and Defib Analyzer.
2. Place the analyzer into the appropriate mode for Synchronized Cardioversion.
3. Ensure the R Series is in "Defib" mode for an ALS device or the mode selector is in the "ON" position for a BLS/Plus device. Confirm "Manual" mode if necessary.
4. Ensure the cardiac monitor is outputting an ECG Signal to the ECG input on the R Series.



	Procedure	Pass/Fail
9.1	On the analyzer simulate a Normal Sinus Rhythm at 60 BPM.	
9.2	On the R Series press the "**SYNC**" softkey to enable synchronized cardioversion.	
9.3	Verify that sync markers appear over each "R" wave in the ECG signal. The sync markers appear as a down arrow over each R Wave peak.	o o
9.4	Press the "**Charge**" button to charge the R Series to any Joule setting.	
9.5	When the shock button illuminates, press and hold the **SHOCK** button to deliver energy.	
9.6	On the analyzer, verify the sync delay is less than 60 ms.	o o

10.0 Pacer Output Test

Equipment Pacer analyzer, Multi-Function cable

Test Setup

1. Following the diagram below, connect the cardiac monitor between the R Series and Defib Analyzer.
2. Connect the R Series to a Pacer Analyzer via the OneStep MFC.
3. Enter the appropriate mode for receiving pacing current on the analyzer. Load resistance must be less than 250 Ohms.

Pacing Controls

	Procedure	Pass/Fail
10.1	Set the pacer to 14 mA, and disconnect the OneStep cable from the analyzer. Verify that the “Check Pads” message appears and the alarm activates.	o o
10.2	Reconnect the OneStep cable to the analyzer, and press the “Clear Pace Alarm” soft-key. Verify that the alarm is no longer active.	o o
10.3	With the analyzer, observe for rate and output based on the below instructions.	
10.4	Set Rate to 70 ppm and Output to 0 mA. Verify no output detected.	o o
10.5	Set Rate to 70 ppm and Output to 20 mA. Verify Output is 20 mA +/- 5 mA and Rate is between 69–71 ppm.	o o
10.6	Set Rate to 180 ppm and Output to 140 mA.Verify Output is 140 mA +/- 7 mA and Rate is between 177.3–182.7 ppm.	o o
10.7	Verify pulse width is 40 ms +/- 2 ms.	o o
10.8	Using the last settings in the chart above, press and hold the **4:1** Button. Ensure the pacer rate is between 44.3–45.6 PPM.	o o

11.0 Synchronized Pacing Test

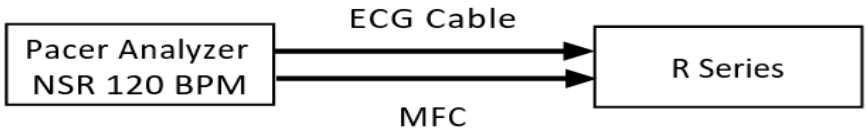
Equipment Pacer analyzer, OneStep Multi-Function cable, ECG cable

Test Setup

1. Turn the main selector knob down to “PACER” mode. Confirm “Manual” mode if necessary.
2. Connect the R Series to the analyzer via the OneStep cable.
3. Connect ECG leads from the R Series to the analyzer.

Note: Performing this test does not require a specific energy selection to be selected. Any energy selection (including 0 mA) may be chosen. This test evaluates the device’s synchronized pacing algorithm, and a pass/fail result is determined by whether or not the presence of stimulus markers appear or disappear during the test. As long as the simulated HR is greater than the chosen PPM setting, the stimulus markers should not be present and the test result should be considered a “pass”.

	Procedure	Pass/Fail/NA
11.1	Set the pacer rate to 100 PPM, and then simulate a Normal Sinus Rhythm (NSR) at 120 BPM. Lead selection should be set to ECG Lead II.	
11.2	A NSR at 120 BPM +/- 2 is displayed and no stimulus markers appear on the display.	o o o
11.3	Press the **ASYNC** or **FIXED PACING** softkey.	
11.4	Verify the **ASYNC PACE** or **FIXED PACE** message appears on the display and stimulus markers are now visible.	o o o



12.0 SpO_2 Function Check (if applicable)

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 only.

Equipment SpO_2 simulator, SpO_2 cable and sensor

Test Setup 1. Turn the main selector knob to "On" or "Monitor" mode. Confirm "Manual" mode if necessary.

	Procedure	Pass/Fail
12.1	Inspect the SPO_2 sensor for any signs of damage or excessive wear	o o
12.2	Place the SPO_2 sensor onto an appropriately sized finger and ensure that the sensor's emitter is placed directly over the fingernail. Ensure that the sensor is shielded from any bright ambient light sources.	
12.3	View the SPO_2 pleth and verify that the waveform is present and without signs of artifact. **Note:** Certain cardiac arrhythmias such as Atrial Fibrillation may produce irregular rate and waveform irregularities.	o o
12.4	Verify SPO_2 readings are between 93–100%.	o o
Note: If the SPO_2 waveform does not automatically appear, you can display it by using the softkeys below the screen to enable the setting. Navigate to: Options>Traces>Trace 3>SPO2. Any changes will revert back to default settings after a 10 second power cycle.		
Note: Individuals with certain diseases of the lungs such as COPD or emphysema may chronically have SPO_2 saturation levels below 95%.		

13.0 $EtCO_2$ Functional Test (if applicable)

Equipment CAPNOSTAT 5 Mainstream of LoFlo Sidestream module

Test Setup

1. Turn the main selector knob to “On” or “Monitor” mode. Confirm “Manual” mode if necessary.
2. Ensure the EtCo2 accessory is connected to the R Series.
3. Install the airway adapter/consumable to the sensor or module.

Note: The R Series may or may not be configured to initialize the $EtCO_2$ sensor upon power up. The warm up period may last up to 3 minutes. If the “WARM UP” message does not appear on the display and the $EtCO_2$ parameter window displays “Disabled”, you must enable the feature by navigating to: Param>CO2>Enable EtCO2.

	Procedure	Pass/Fail
13.1	When the “WARM UP” message disappears, press the Param softkey, then select $EtCO_2$.	
13.2	Press the **ZERO** softkey, and wait for the zeroing process to complete, this will take approximately 10 seconds. Verify that the “ZERO DONE” message appears on the display.	o o
13.3	Press the Return softkey.	
13.4	If not already displayed, enable the EtCO2 waveform by navigating to: **Options>Traces>Trace 2>EtCO2.**	
13.5	Verify that a flat baseline appears within the trace.	o o
13.6	Breathe normally into the airway adapter and verify that a capnograph waveform appears on the display.	o o

14.0 CO_2 Accuracy Check (if applicable)

Equipment CAPNOSTAT 5 Mainstream of LoFlo Sidestream module, 5% CO_2 calibration gas (AirGas PN: Z03NI748PDC004), barometer

Test Setup

1. Ensure the $EtCO_2$ accessory is connected to the R Series.
2. Connect the mainstream or sidestream disposable adapter to the accessory.
3. If currently powered on, turn off the R Series and wait 10 seconds. Then, turn the device to either the "On" or "Monitor" positions while continuing to press and hold the second softkey.

Note: The R Series may or may not be configured to initialize the $EtCO_2$ sensor upon power up. The warm up period may last up to 3 minutes. If the "WARM UP" message does not appear on the display and the $EtCO_2$ parameter window displays "Disabled", you must enable the feature by navigating to: Param>CO2>Enable EtCO2.

	Procedure	Pass/Fail
14.1	Press the **Baro Pr.** softkey to enter the Barometric Pressure Calibration screen.	
Note: The Barometric Pressure displays as the second value in mmHg. As an example, if the values shown are 3530, 760 then the barometric pressure measurement is 760 mmHg.		
14.2	Use the **Inc>** and **Dec<** softkeys to adjust the measurement to your local barometric pressure. Verify that the Barometric Pressure displayed on the R Series matches your local pressure reading. **Note:** For accurate results, measurements should be compared against a calibrated barometer. **Note:** The barometric pressure displayed on the R Series is **uncorrected**, meaning it is not adjusted for elevation/altitude. Verify the barometer you are comparing the R Series to is also displaying an **uncorrected** barometric pressure reading.	o o
14.3	Press the **Return** softkey to store the offset and return to the main calibration screen.	
Note: If the CO2 WARM UP message is displayed, wait for the message to disappear before continuing. This may take up to 3 minutes.		
Note: If the ambient temperature of the room is different than the temperature in Celsius shown on the display, adjust the temperature by choosing Select Gas Temp followed by increasing or decreasing as needed. Press "Return" when complete.		
14.4	Once the "CO2 WARM UP" message disappears, press the **Zero** softkey to zero the sensor. Verify "ZERO DONE" is shown on the display once complete.	o o
14.5	Attach a regulated flowing gas mixture of 5% CO_2, balance Nitrogen (N_2) to the airway adapter. The gas flow rate should already be preset to 2–5 liters per minute (LPM) for mainstream, or 2 LPM if utilizing the LoFlo sidestream module.	

	Procedure	Pass/Fail
14.6	Allow several seconds for the gas mixture to stabilize and observe the CO_2 Percent value. Verify the CO_2 percentage is between 4.8–5.2%.	o o
14.7	Once complete, you may turn off the device.	

The calibration gas is available from AirGas Healthcare/Air Liquide Customer Service. If sourcing the calibration gas elsewhere, ensure it is medical grade and has a composition of 5% CO_2 21% O_2 Balance N_2.

Calibration Gas part number: Z03NI748PDC004 (AirGas Healthcare/Air Liquide).

Gas Regulator OEM part number: 989805601321 (Regulator, Model 1298 by Philips Healthcare)

Note: The calibration gas and the gas regulator are **not** products sold by ZOLL.

15.0 Paddles Test (if applicable)

Equipment External paddles, Multi-Function cable, defibrillator analyzer

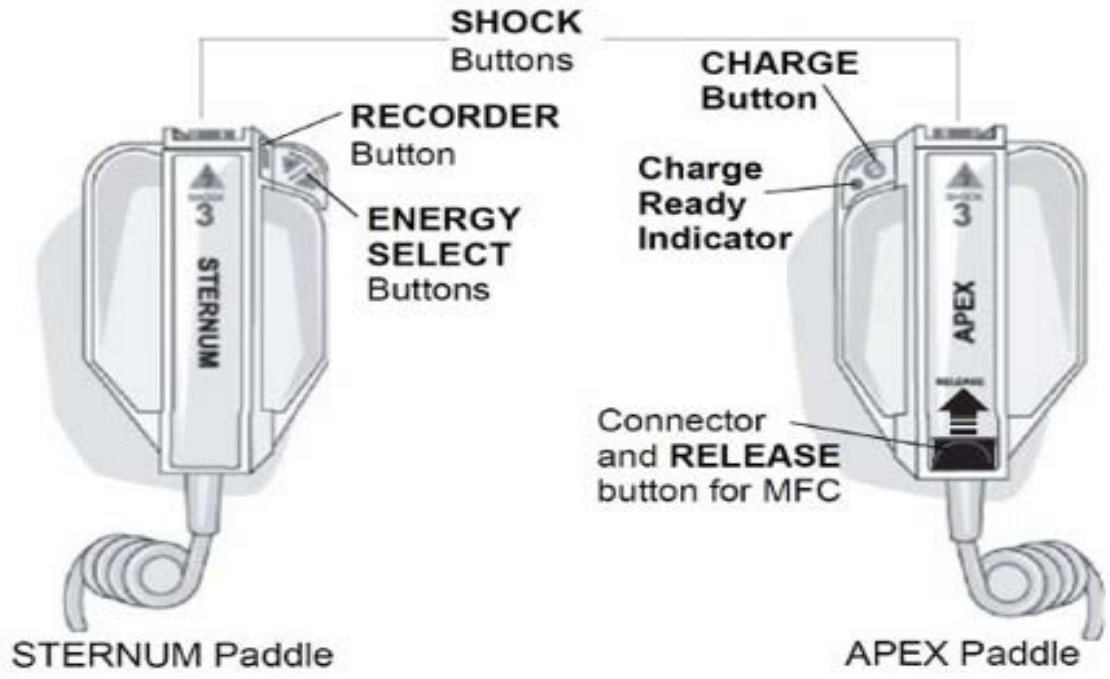
Test Setup
1. Connect the Multi-Function cable to the paddles.
2. Connect the paddles into each side well on the R Series.
3. Turn the main selector knob to “On” or “Defib” mode. Confirm “Manual” mode if necessary.

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.

Caution Do NOT internally discharge the unit more than 3 times in the span of 1 minute. Multiple rapid internal discharges at more than 30J may damage the unit.



	Procedure	Pass/Fail
15.1	Press the **ENERGY SELECT DOWN** button on the sternum paddle and verify that the energy level decreases.	o o
15.2	Press and release the **ENERGY SELECT UP** button on the sternum paddle and verify that the energy level increases.	o o
15.3	Press and release the **RECORDER** button on the sternum paddle. Verify that the recorder starts printing. You may press the button a second time to stop printing.	o o
15.4	Using the **Energy Select** Buttons on the paddles, select 30 Joules, and then press the **CHARGE** button on the APEX Paddle.	o o
15.5	Verify that the unit charges to 30J and the red LED charge indicator on the apex paddle illuminates.	o o
15.6	Press and release the **APEX SHOCK** button. Verify the unit does not discharge.	o o
15.7	Press and release the **STERNUM SHOCK** Button. Verify the unit does not discharge.	o o
15.8	Press and hold both **SHOCK** buttons on the paddles. Verify the unit discharges. The unit displays "30 J Test OK" on the display. If configured, the recorder prints a strip chart. Note that the 30 J Test OK message will only display briefly.	o o

16.0 NIBP Leak Test (if applicable)

Equipment NIBP analyzer, NIBP tubing, NIBP cuff (adult size) or rigid volume

Test Setup

1. Connect the R Series to the analyzer, along with either an adult size cuff or rigid volume. If using a patient cuff, the cuff should be tightly wrapped around a rigid container.
2. If currently powered on, turn off the R Series, wait 10 seconds and then turn the device to either the “On” or “Monitor” positions while pressing and holding the fourth softkey.

Note: The volume leak test verifies the integrity of the pneumatic system on the R Series NIBP module. This test should be performed annually or every 10,000 readings, whichever comes first.

	Procedure	Pass/Fail
16.1	Press the Leak Test key and enter the R Series leak test mode.	
16.2	On the NIBP analyzer, set the pressure parameter to 200 mmHg.	
16.3	On the NIBP analyzer, set the test duration to 1 minute.	
16.4	On the R Series unit, press the Close Valves softkey. Verify the Valves status changes from OPEN to CLOSED. **Note:** The NIBP valves will remain closed for a maximum of 3 minutes. After 3 minutes, the valves will automatically open.	o o
16.5	On the analyzer, begin the test ensuring that the simulator pressurizes to 200 mmHg, with a duration of 1 minute.	o o
16.6	After 1 minute, verify that the leak rate is less than 5.5mmHg.	o o
16.7	When complete, press the “Exit” soft key to return to the NIBP Service Mode.	

17.0 NIBP Calibration Test (if applicable)

Equipment NIBP analyzer, NIBP tubing, NIBP cuff (adult size) or rigid volume

Test Setup

1. If continuing from the previous test (NIBP Leak Test), proceed to step 17.1 immediately.
2. Connect the R Series to the analyzer, along with either an adult size cuff or rigid volume. If using a patient cuff, the cuff should be tightly wrapped around a rigid container.
3. If currently powered on, turn off the R Series, wait 10 seconds, and then turn on the device to either the “On” or “Monitor” positions while pressing and holding the fourth softkey.

	Procedure	Pass/Fail
17.1	Under the NIBP Service Mode, press the **NIBP Calib** soft key. The R series will then enter the transducer calibration menu.	
17.2	On the NIBP analyzer, set a pressure of 0 mmHg.	
17.3	On the R Series, press the Set Low softkey to zero the transducer. Verify that the field adjacent to the 0 mmHg value changes to PASS. **Note:** If the R Series displays a “FAIL” message, verify the NIBP analyzer’s pressure setting and connection to the R Series then repeat the step.	o o
17.4	On the NIBP analyzer, set a pressure of 250 mmHg. Wait for the pressure to stabilize.	
17.5	On the R Series, press the **Set High** softkey to calibrate the transducer. Verify that the field adjacent to the 250 mmHg value changes to “PASS”.	o o
17.6	On the NIBP simulator, change the pressure value to simulate a different cuff pressure (for example, 205 mmHg). Wait for the pressure to stabilize.	o o
17.7	On the R Series, press the **Read Cuff** softkey. Verify that the value displayed is accurate within ±3 mmHg of the pressure parameter set on the NIBP simulator.	o o
17.8	On the R Series unit, press the **EXIT** softkey twice and return to clinical monitoring mode.	

18.0 Leakage Current Test

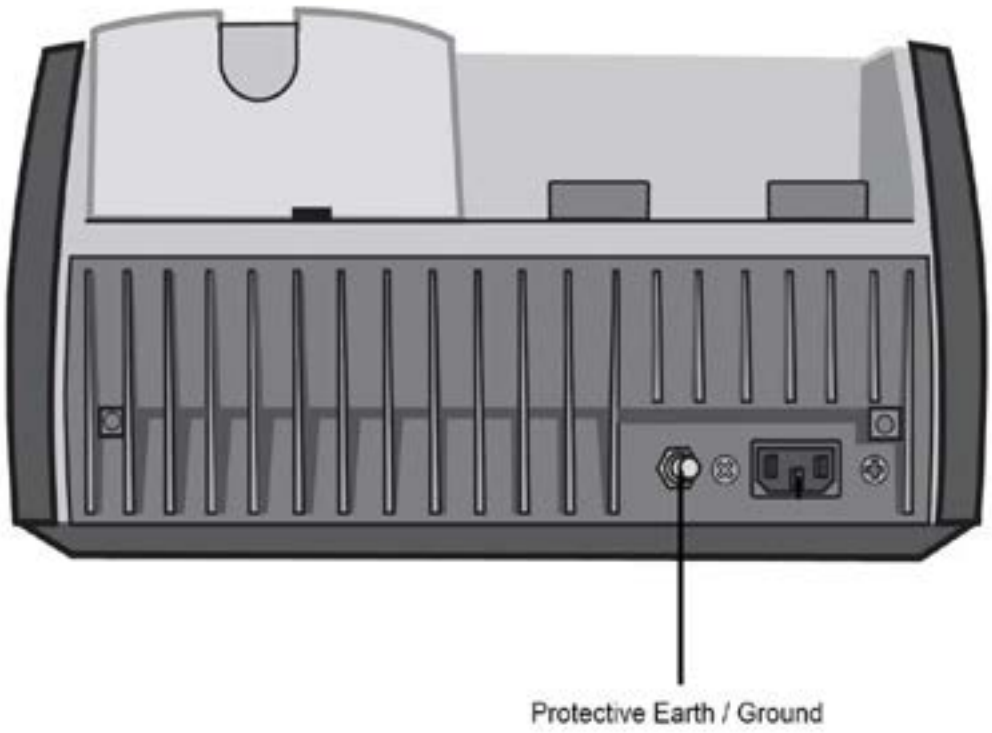
Equipment Electrical safety analyzer

Test Setup Refer to the manufacturer's instructions or supplied specifications for the leakage tester you use. Repeat the leakage test with accessories: MFC cable, paddles, and ECG leads. Perform these tests at the line-power voltage and frequency used in your installation. The ZOLL R Series is a Class 1 medical device, certified to IEC 60601-1 with CF and BF applied parts.

WARNING! 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.

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

Perform leakage current testing in accordance with either of the following electrical safety standards:
IEC (International Electrotechnical Commission) 62353 for recurrent test and test after repair of medical electrical equipment
IEC (International Electrotechnical Commission) 60601-1.



IEC 60601-1 LEAKAGE TEST LIMITS				
	TYPE BF**		TYPE CF*	
	NC	SFC	NC	SFC
Patient Leakage AC	100µA	500µA	10µA	50µA
Patient Auxiliary Current AC	100µA	500µA	10µA	50µA
Mains on Applied Parts	N/A	5000µA	N/A	100µA (Internal Paddles) 50µA (ECG)

	Normal Condition	Single Fault Condition
Earth Leakage	500µA	1000µA
Enclosure Leakage	100µA	500µA

NOTES		
*	**CF**	ECG, Internal Paddles
**	**BF**	PADS, Paddles

IEC 62353 CLASS 1 LEAKAGE TEST LIMITS-DIRECT METHOD		
	TYPE BF**	TYPE CF*
Equipment Leakage	500µA	500µA
Patient Leakage Current	5000µA	50µA

NOTES		
*	**CF**	ECG, Internal Paddles
**	**BF**	PADS, Paddles

	Procedure	Pass/Fail
18.1	Verify that all electrical safety testing/leakage measurements are within allowable limits.	o o

19.0 CPR Feedback Test (if applicable)

Note: This test is only applicable to devices configured for CPR Feedback. Depending on purchased options and software version, the CPR dashboard may appear different than illustrated on the following page.

Note: The following procedure contains two options for completing a functional check of the CPR feedback circuitry. Either option may be utilized as an acceptable method for this test procedure.

Equipment OneStep MFC, OneStep Training Cable (ZOLL P/N: 8900-0180), Defibrillator analyzer

Test Setup

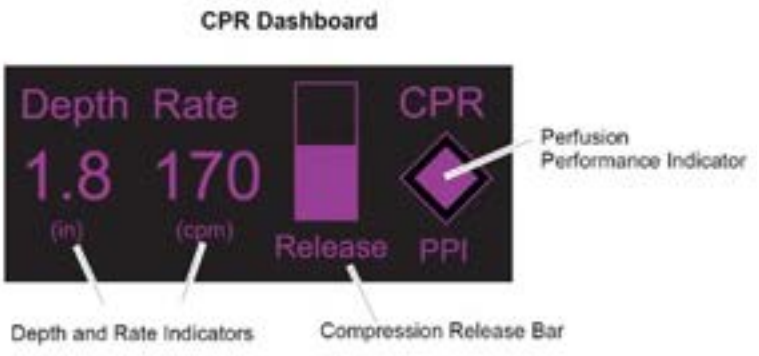
1. Connect the R Series OneStep MFC to the OneStep Training Cable.
2. Connect the OneStep Training Cable to the Defib analyzer.
3. Turn the main selector knob to the “Defib” or “On” position. Confirm “Manual” mode if necessary.

Option 1		
	Procedure	**Pass/Fail/NA**
19.1	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.	
19.2	While compressions are performed, verify that CPR feedback is displayed on the screen. Note that depth and rate numerics may not display depending on device configuration.	o 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 Defib analyzer.		
Note: The training sensor is not pressure sensitive. It requires physical movement which is measured via an accelerometer.		

Equipment OneStep MFC, OneStep to CPR-D Adapter (PN: 8009-0020), ZOLL AED Simulator (PN: 8000-000925)

Test Setup
1. Connect the R Series OneStep MFC to the ZOLL AED Simulator by way of the OneStep to CPR-D Adapter.
2. Turn the main selector knob to the “Defib” or “On” position. Confirm “Manual” mode if necessary.

Option 2		
	Procedure	**Pass/Fail/NA**
19.3	Press the power button on the AED Simulator followed by pressing the CPR button on the Simulator’s control panel.	
19.4	Verify that CPR feedback displays on the screen. Note that depth and rate numerics may not display depending on device configuration.	o o o
Note: CPR feedback will not register until a valid impedance is detected. If CPR feedback does not activate, check all connections between the OneStep MFC, Adapter, and Simulator.		
Note: During simulation it will be expected to see intermittent pauses of CPR feedback during this procedure. The ZOLL AED Simulator simulates CPR at a 2/30 ratio. After 30 compressions the simulation will pause to allow for 2 breaths before compressions resume.		



20.0 Wi-Fi Card Functionality Test (optional)

Note: This test is optional but recommended. A functional Wi-Fi card is essential for daily clock sync and to prevent potential loss of patient data and/or device history data.

Equipment R Series printer paper (P/N: 8000-000877-01), extra “known good” Wi-Fi card (optional)

Test Setup

1. Verify the R Series Wi-Fi card is configured correctly to connect to the network and transmit data to the ZOLL server.
2. Determine what the Wi-Fi card is configured to send to the ZOLL server (Full Disclosure File, Device History, or both). See **Print Config** section on the following pages for instructions on how to do this. The configuration of the Wi-Fi card will determine which test instructions that you should follow below (Test 1 or Test 2).
3. Verify a Wi-Fi access point is nearby that the R Series is expected to be able to connect to.
4. Optional: Have an extra “known good” Wi-Fi card on hand to swap out with a bad Wi-Fi card (if one is discovered during testing).

Perform **Test 1** if the R Series is configured to transfer the Full Disclosure File to the ZOLL server.

Perform **Test 2** if the R Series is configured to transfer the Device History to the ZOLL server.

Test 1: To test Wi-Fi connectivity for Full Disclosure File (CaseReview)		
Step	**Procedure**	**Pass / Fail**
20.1	Turn the R Series to “On” or “Monitor” mode.	
20.2	Press the fourth softkey to access Report Data.	
20.3	Press the fifth softkey to access Transfer Mode.	
20.4	Press the second softkey to access Report to Wi-Fi.	
20.5	If the transmission was successful, the R Series will display Full Disclosure File has sent. If the transmission was unsuccessful, or if an error is displayed, take note of the error and try to send the transmission again. See Troubleshooting section if error persists.	o o

Test 2: To test Wi-Fi connectivity for Device History (Defibrillator Dashboard or Device Dashboard)		
Step	**Procedure**	**Pass / Fail**
Note: If you have just sent the Full Disclosure File to the server, skip to step 20.9.		
20.6	Turn the R Series to “On” or “Monitor” mode.	
20.7	Press the fourth softkey to access Report Data.	
20.8	Press the fifth softkey to access Transfer Mode.	

Test 2: To test Wi-Fi connectivity for Device History (Defibrillator Dashboard or Device Dashboard)		
Step	**Procedure**	**Pass / Fail**
20.9	Press the fifth softkey to access More.	
20.10	Press the second softkey to access Defib History to Wi-Fi.	
20.11	If the transmission was successful, the R Series will display Defib History has sent. If the transmission was unsuccessful, or if an error is displayed, take note of the error and try to send the transmission again. See Troubleshooting section if error persists.	o o

Troubleshooting

It may take up to three times for a successful transfer. If transfer attempts fail more than 3 times, this could be indicative of an issue with data transfer. Please email supportdata@zoll.com or call ExpertCare Data Support at (800)348-9011.

Note: If the R Series must be returned to the crash cart with no Wi-Fi card, it is strongly recommended to change the configuration settings to disable data transfer. This will help ensure that clinical data is not prematurely deleted from the device before it is successfully transferred to Wi-Fi or to Card. See Data Transfer Configuration later in this document.

Error Code	Description	Technical Action
-7507	Network Error: General	Contact Support to replace Wi-Fi card
-7511	Certificate Expired	Check date/time on the R Series. If correct and the error persists, contact your IT department.
-7001, -7007	Wi-Fi Network Not Found, Authentication Error	Move closer to the Wi-Fi access point and try the Data Transfer again.
All other errors	Not applicable	Try the Data Transfer again. If error persists, contact Support.

Print Config

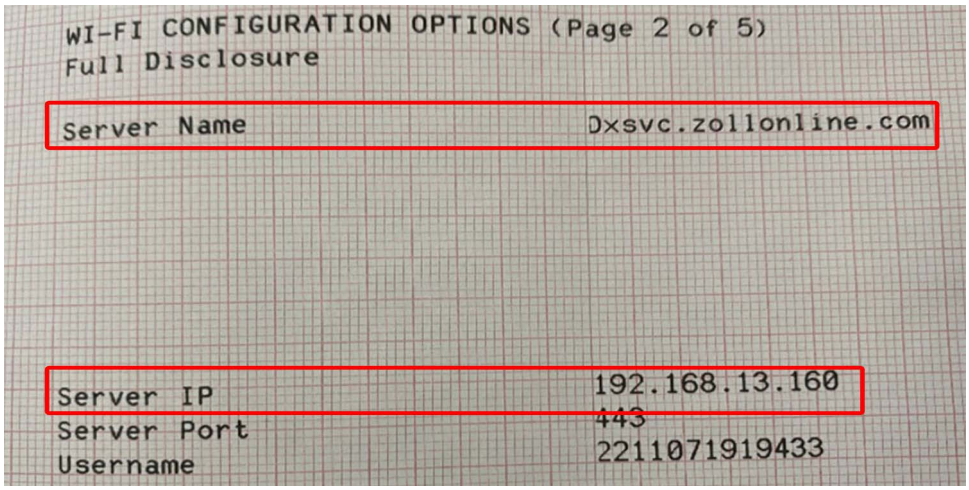
On the R Series, enter the System Configuration Mode.

1. Press the second softkey: Print

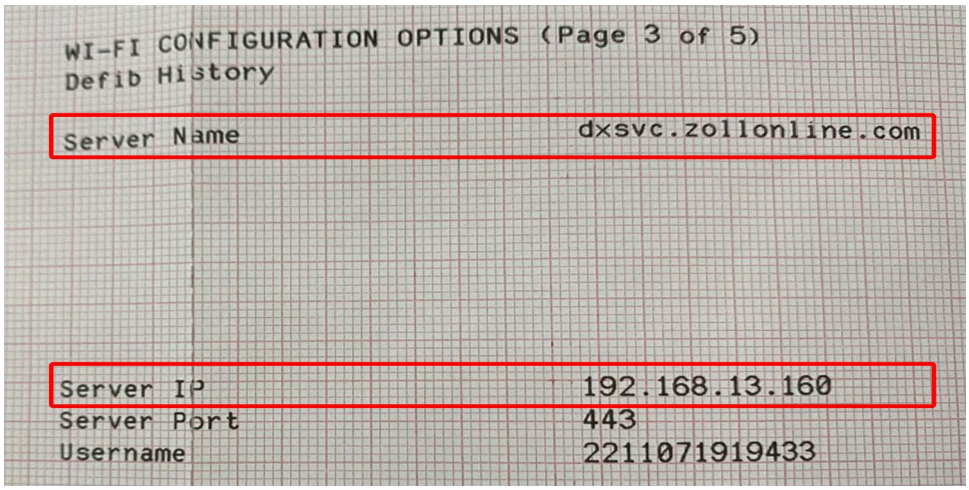
2. Press the first softkey: Print Config

Determine which Wi-Fi Tests (Test 1 or Test 2) to run by confirming if Full Disclosure File and/or Defib History is configured under the Wi-Fi Configuration Options, and determine if they are configured to allow a Manual transfer under the Wi-Fi Data Transfer options.

On the printout, the Wi-Fi Configuration options are the last sections to print. Look at the **Wi-Fi Configuration options for Full Disclosure File** (page 2 of 5 on the printout). Under Full Disclosure, the presence of a Server Name and/or Server IP indicates the R Series is configured to transfer a Full Disclosure File. Follow the instructions for Test 1 above.



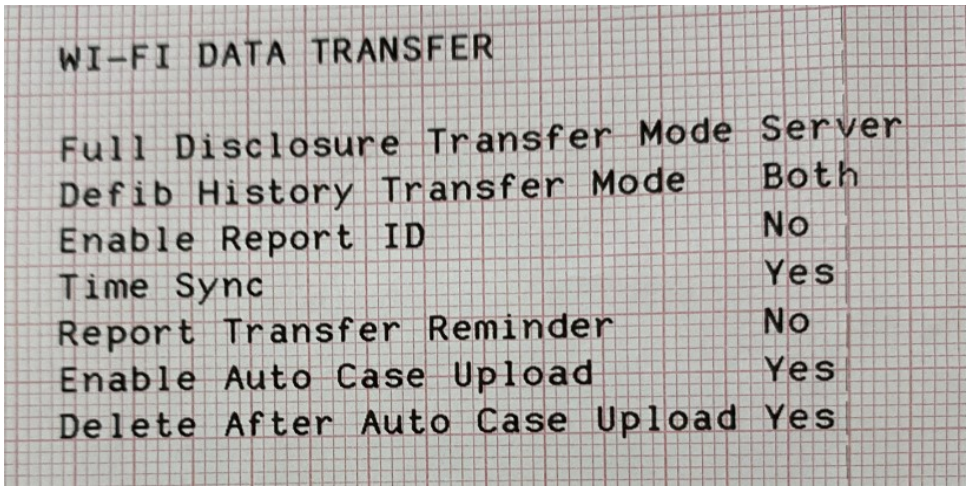
Next, look at the **Wi-Fi Configuration options for Defib History** (page 3 of 5 on the printout). Under Defib History, the presence of a Server Name and/or Server IP indicates the R Series has Defib History configured. Follow the instructions for Test 2 above.



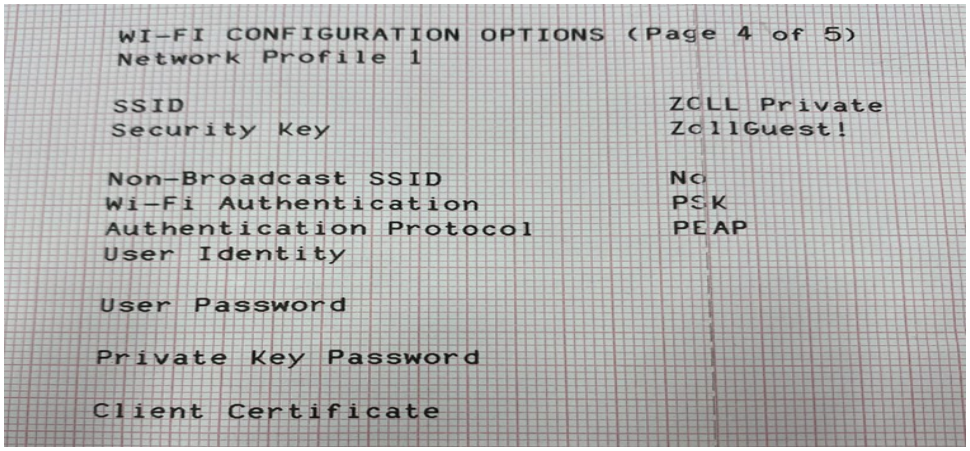
Look at Wi-Fi Data Transfer.

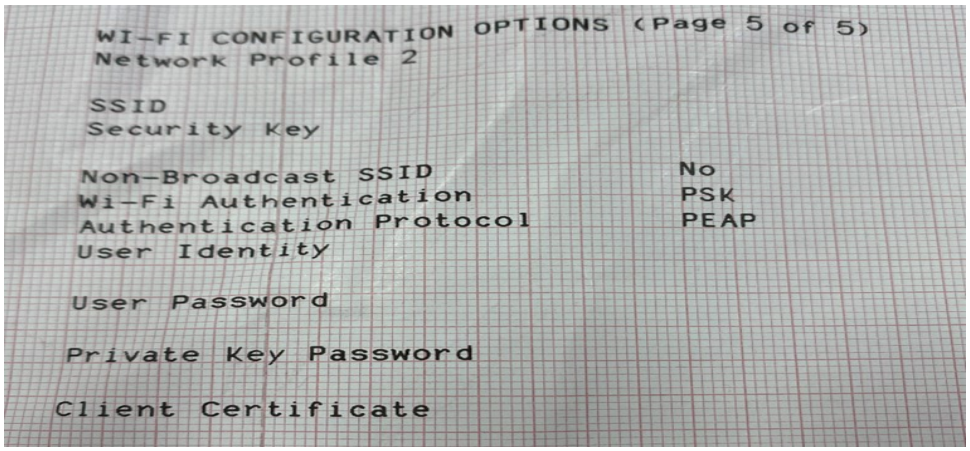
- If Full Disclosure was configured for Wi-Fi, Full Disclosure Transfer Mode must be set to Server in order to perform Test 1 above.

- If Defib History was configured for Wi-Fi, Defib History Transfer Mode must be set to Both in order to perform Test 2 above.



Determine which Access Point(s) SSID(s) the R Series is configured to connect to by looking at the two configured Network Profiles found under **Wi-Fi Configuration Options** on the printout (pages 4 and 5).





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 problems you encounter are not listed below, contact ZOLL Medical Corporation's Technical Service Department for further assistance.

Error Messages

The following table lists error messages that can appear on the display of an R Series unit. The "User Advisory" column informs you about an action in progress or provides feedback on a user correctable situation that typically does not require further technical support. The "Technical Action" column describes what you as a technician can do to correct the situation. Note that these messages will sometimes overlap part of the waveform display.

First, attempt to clear the message by turning the Selector Switch to OFF for ten seconds, then back to the desired operating mode. If the fault persists, contact ZOLL Technical Service.

Error Message	Explanation	User Advisory	Technical Action
200J MAX BIPHASIC	User attempted to set defibrillation energy >200J on Biphasic Unit. No higher energy is available.	✓	
30 J TEST OK	Unit successfully passed the 30J defib self-test.		
50 J MAX	Energy < 50J for internal paddles. No higher energy is available.	✓	
ALARM SET	ALARM SET status message when setting alarms.	✓	
ANALYSIS HALTED	ECG analysis halted due to user interaction such as: • Lead/size change • Analyze button was pressed again • Impedance fault • Charging error detected in auto defib mode	✓	
ASYNC PACE ONLY	Posted along with other faults. Indicates that the PD module cannot detect sync pulses.	✓	
ATTACH PADS	AED: No pads on Auto Defib power-up.	✓	Verify proper OneStep cable/hands-free therapy electrode connection by disconnecting and reconnecting the OneStep cable and hands-free therapy-electrodes.
AUDIO QUEUE FULL	Indicates that the audio output queue is full. Additional voice prompts can't be queued at this time.		None.
BATT HIGH CURRENT	Battery is not charged and battery current is greater than 1.6 A.		Replace battery or AC charger.
BATT HIGH VOLTAGE	Indicates that the charger voltage is too high.		Replace battery or AC charger.

Error Message	Explanation	User Advisory	Technical Action
BATT LOW VOLTAGE	Indicates that the charger voltage is too low.		Replace battery or AC charger.
BATTERY COMMS ERROR	Battery is not communicating with the host.		Replace battery interconnect board.
BATTERY FAULT			Replace battery.
BATTERY ID FAULT			Replace battery.
CAL. BARO. PRESSURE	Barometric pressure reading is out of range.		Calibrate the barometric pressure.
CALIBRATE NIBP	NIBP calibration is incomplete or failed.		Cycle power and retry; if problem persist calibrate NIBP system.
CANNOT CHARGE	Cannot charge when charge button pressed.		Replace high voltage module or capacitor.
CF TRANSFER FAILED	Summary/DVCK/ALOG data file transfer error – either no CF card or CF card transfer failed		Reseat CF Communication cable or replace Communication Module.
CHANGE LEADS	Unit is in Defib Sync mode and heart rate is less than 20 BPM.	✓	
CHARGE FAILED	Unit failed to perform the requested charge.		Replace PD Engineer or Analog Board.
CHECK CO2 ADAPTER	Airway adapter is removed, occluded or adapter zeroing needs to be performed or was performed incorrectly.	✓	Replace/Clean airway adapter. Zeroing performed automatically.
CHECK CO2 SENSOR	$EtCO_2$ Sensor is unplugged or defective.	✓	Check that sensor cable is plugged in and seated properly. Check that sensor is not exposed to excessive heat. If problem persists, replace the sensor.

Error Message	Explanation	User Advisory	Technical Action
CHECK CUFF/ HOSE	• Blood pressure cuff or hose is not installed correctly. • Cuff or hose is faulty. • Hose is kinked or disconnected. • Inflation rate too fast or too slow.		• Verify the hose and cuff is properly connected and not leaking. • Replace cuff and hose. • Replace NIBP module or parameter power supply.
CHECK ECG CABLE	Invalid ECG cable Id is detected.		• Verify that the ECG Cable is property connected. • Replace ECG Cable. • Replace Analog Board.
CHECK ELECTRODE	Either Can read ID Chip or the checksum failed.		Replace Electrodes or replace Analog board.
CHECK PADS	Message displayed in conjunction with either POOR PAD CONTACT or DEFIB PAD SHORT.	✓	Ensure pads are coupled to patient. Check/ replace pads and universal cable. Replace system board.
CHECK PATIENT	Background ECG analysis detects shockable rhythm.	✓	
CHECK PULSE	Alternate message for NO SHOCK ADV. message, or displayed in addition to it according to the configuration option selected. Also shown after delivering last shock when Auto Analyze option is enabled.	✓	
CHECK RECORDER	Produced when paper tray is empty, paper jams or recorder door is opened.	✓	
CHECK SPO2 SENSOR	Reposition SpO_2 sensor on patient.	✓	
CLOCK BATTERY FAULT	The RTC coin battery has failed.		Replace lithium coin battery or digital board.
CLOCK FAULT 11	Real time clock oscillator failure		Replace lithium coin battery or digital board.

Error Message	Explanation	User Advisory	Technical Action
CLOCK FAULT 12	Real time clock back-up power supply failure. Found oscillator stopped at power-up, but oscillator now running when the system is running (oscillator only runs when main power is applied).		Replace lithium coin battery or digital board.
CLOCK FAULT 13	One of the set time units (seconds, minutes, year, etc.) is out of range.		Replace lithium coin battery or digital board.
CO2 COMM ERROR	No or invalid communication from the $EtCO_2$ module.		Replace $EtCO_2$ module and or system board.
CO2 DEVICE NOT READY	There is CO_2 in the airway adapter when attempting to zero. Zeroing was attempted within 20 seconds of previous zero operation.		• Remove airway adapter from CO_2 source including the patient's, and your own exhaled breaths, and ventilator exhaust valves. • Wait up to 20 seconds before retrying a mainstream airway adapter zero, as described in "Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter"
CO2 IN LINE: WAIT	Adapter zero attempted with CO_2 in the adapter.	✓	
CO2 MODULE NOT VALID	Sidestream sensor connected (not supported by the R Series unit's operating software)		Use mainstream sensor.
CO2 OUT OF RANGE	The calculated CO_2 value is greater than 150 mmHg.		If error persists, perform a mainstream airway adapter zero, as described in "Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter."

Error Message	Explanation	User Advisory	Technical Action
CO2 UNIT ERROR	The $EtCO_2$ sensor or module has detected a hardware error.		Check that the sensor is properly plugged in. Re-insert the sensor. Turn R Series unit off, then on again to reset. perform a mainstream airway adapter or module zero, as described in "Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter". If the problem persists, contact ZOLL Technical Support.
CO2 WARM UP	The mainstream sensor is warming up. This may take up to 5 minutes.	✓	Wait for sensor or module to warm up. If the message persists more than 5 minutes, replace the sensor.
CPR FAULT 8	ECG processor not receiving CPR data		Replace analog board.
DATA TRANSFERRED	Transfer done message	✓	
DEFIB DISABLED	User prompt issued simultaneously with other faults if defib is disabled.		Possible configuration problem. Replace high voltage module. Call ZOLL Technical Support.
DEFIB FAULT 76	PD Defib failure during POST.		Replace PD engine.
DEFIB FAULT 77	PD Defib failure while running.		Replace PD engine.
DEFIB FAULT 78	PD Defib functional safety error while running.		Replace PD engine.
DEFIB FAULT 79	PD module Defib/Pace failure during POST.		Replace PD engine.
DEFIB FAULT 80	Undefined error received from the PD module.		Replace PD engine.

Error Message	Explanation	User Advisory	Technical Action
DEFIB FAULT 94	PD module reset 3 times without being requested to.		Replace PD engine.
DEFIB FAULT 95	PD module not communicating.		Replace PD engine.
DEFIB FAULT 96	PD module reported an error on the discharge.		Replace PD engine.
DEFIB MAINT. REQ.	More than 5000 discharges of 200J have occurred. Maintenance is required.		Replace PD engine.
DEFIB NOT CHARGED	Discharge button is pressed in a Defib mode but the unit is not charged.	✓	
DEFIB OVERUSE	More than 50 shocks were delivered in less than 20 minutes.		Unit needs to cool down, wait approximately 5 minutes.
DEFIB PAD SHORT	Measured impedance between high voltage leads of MFC.	✓	Ensure pads are coupled to patient. Check/ replace pads or universal cable. Replace system board.
DISK FORMAT REQ.	Report error if any problem with DOC file access occurred.		Replace digital board.
ECG DISABLED	Persistent Critical Hardware Failure on ECG module.		Replace analog board.
ECG FAULT 200	No ECG applicable available.		Reload MCU Software and ECG App. Software.
ECG FAULT 3	ECG processor reset failure.		Replace analog board.
ECG FAULT 4	Excessive number of missed samples from ECG processor.		Replace analog board.
ECG FAULT 5	ECG processor power up failure.		Replace analog board.
ECG FAULT 6	ECG processor Hardware failure.		Replace analog board.
ECG FAULT 7	ECG processor is not responding.		Replace analog board.
ECG LEAD OFF	1 or more ECG leads are not connected when non-MFE leads are selected as input.	✓	

Error Message	Explanation	User Advisory	Technical Action
ECG RA LEAD OFF	ECG lead RA is disconnected	✓	
ECG TOO LARGE	Number of intervals with large ECG exceeds threshold. Issued immediately before RETRY ANALYSIS.	✓	
ECG V LEAD OFF	ECG lead V is disconnected	✓	
ENABLE ETCO2	User attempts to zero $EtCO_2$ sensor while the $EtCO_2$ feature is disabled	✓	Using the softkeys, select Enable EtCO2.
ENERGY INCREMENTED	Defib energy has been automatically incremented to the next configured level after shock 1 or 2 has been delivered and the unit is configured for Basic Energy Auto Escalation.	✓	
ERASING REPORT	The unit is erasing the selected report data.	✓	
FULL DISCLS STOPPED	Full disclosure data exceeds the storage capacity: 4 hours or 32Mb.	✓	
IF NO PULSE	Message displayed upon entered CPR period specified by AHA protocol.	✓	
INSERT CARD	No card detected during manual or semi-automatic modes.	✓	Re-insert CF Card or replace communication module.
INT. DUMP OVERLOAD	More than 15 internal discharges in 5 minutes.		Unit needs to cool down, wait approximately 5 minutes.
INVALID GAS TEMP: RETRY	The operator has attempted to set a gas temperature outside the Capnostat's operating range.		Recalibrate $EtCO_2$, verify range.
LOW BATTERY	Low battery.	✓	• Replace battery pack with a fully charged battery pack. • Plug unit into AC mains.

Error Message	Explanation	User Advisory	Technical Action
NIBP ARTIFACT	The unit is unable to detect systolic, diastolic or mean blood pressure due to excessive motion or vibration.		• Take a single blood pressure measurement. • Keep patient as still as possible. • Insulate patient, cuff and hose from vibrations as much as possible.
NIBP COMM ERR 259	Framing, parity, or fifo error.		Replace parameter power supply or NIBP module.
NIBP COMM ERR 260	Received invalid packets.		Replace parameter power supply or NIBP module.
NIBP COMM ERR 261	Device not taking action request.		Replace parameter power supply or NIBP module.
NIBP COMM ERR 262	No reply from device.		Replace parameter power supply or NIBP module.
NIBP FAULT 263	Fault 90 received from NIBP module.		Replace NIBP module.
NIBP FAULT 264	Fault 91 received from NIBP module.		Replace NIBP module.
NIBP FAULT 265	Fault 97 received from NIBP module.		Replace NIBP module.
NIBP FAULT 266	Fault 98 received from NIBP module.		Replace NIBP module.
NIBP FAULT 267	Fault 99 received from NIBP module.		Replace NIBP module.
NIBP FAULT 268	Device no response after power up.		Replace NIBP module.
NIBP MEAS ABORTED	• Cuff inflation pressure is set too high for attached cuff. • Inflation is too fast. • R Series is unable to find systolic value for 180 seconds. • Defibrillator is charged or charging. • User initiated abort.		• Verify that you are using proper size cuff. • Check for cuff and hose blockage.\ • Confirm that the unit was not charging. • If the problem persists, contact ZOLL Technical Support.

Error Message	Explanation	User Advisory	Technical Action
NIBP NOT READY	• The defibrillator is charged or charging in progress. • NIBP module is performing power-up self-test.		• Wait until the unit discharges before taking the next measurement. • Wait for more than 10 seconds after power-up before taking blood pressure measurements.
NIBP OUT OF RANGE	The data from the NIBP module is out of range.		• Check cuff fit and positioning. Switch cuff to other arm. • Measure patient's blood pressure with other equipment. • If the problem persists, contact ZOLL Technical Support.
NIBP SIGNAL WEAK	There is a weak or no oscillometric signal.		• Check cuff fit and positioning. • Check for kinked hose. • Increase cuff inflation pressure if clinically appropriate.
NO DATA TO TRANSFER	Summary Report / Device Check / Activity Log data transfer error.	✓	
NO QRS DETECT	Unit is in sync mode and heart rate is < 20 BPM or QRS amplitude is too low for proper synchronization.	✓	Increase ECG size and/ or change lead.
NO SHOCK ADV.	No shock advised. Advisory message when analysis finds non-shockable rhythm.	✓	
NOISY ECG	Number of noisy analysis intervals exceeds threshold.	✓	Stop all patient movement. Check connections. Press Analyze button again.
OPEN AIR DISCHARGE	Measured Defib Impedance was greater than 1000 ohms and no energy was delivered.	✓	
PACER DISABLED	User prompt issued simultaneously with other pace faults if pacing is disabled.		Replace high voltage module or system board.

Error Message	Explanation	User Advisory	Technical Action
PACER FAULT 115	PD Pace failure during POST.		Replace PD engine.
PACER FAULT 117	PD Pace functional safety failure while running.		Replace PD engine.
PACER FAULT 121	PD Pace failure while running.		Replace PD engine.
PACER FAULT 122	PD module Defib/Pace failure during POST.		Replace PD engine.
PACER WARNING 124	PD Pace warning while running.		Replace PD engine.
PADDLE FAULT	Cannot detect type of accessory attached to the universal cable.		Replace paddles, internal paddles, system board, high voltage module and/or universal cable.
PEDIATRIC PADS IN USE	The one of the Pediatric ID is missing.		
PERFORM CPR	Message displayed upon entered CPR period specified by AHA protocol.	✓	
POOR LEAD CONTACT	One or more ECG leads are poorly connected or not connected to patient. (User configurable.)		Check electrode attachment to patient, cable connector to electrode, and cable to unit connector.
POOR PAD CONTACT	Electrode impedance exceeds threshold.		• Ensure pads are coupled to patient. • Check/replace pads or universal cable. • Check impedance circuit calibration. • Replace system board.
PRESS ANALYZE	Alternate message for Check Patient message if this configuration option is selected.	✓	
PRESS CHARGE	• Discharge button is pressed in Manual Defib mode but the unit is not charged. • Advisory message following SHOCK ADVISED in Manual/Advisory Defib mode with auto-charge disabled.	✓	

Error Message	Explanation	User Advisory	Technical Action
PRESS SHOCK	Prompt issued in AED auto defib mode when defib is charged (ready).	✓	
READING LOG DATA	Summary Report Log data printing message.		
RECORDER FAULT 142	Strip chart system error.		Replace printer assembly, digital board, and/or printer interconnect board.
RECORDER FAULT 143	Strip chart failed power-up echo test.		Replace printer assembly, digital board, and/or printer interconnect board.
RECORDER FAULT 147	Strip chart printhead over safe operating temperature.		Replace printer assembly, digital board, and/or printer interconnect board.
RELEASE BUTTONS	Simultaneous external paddle button presses detected before unit reached full defib charge (ready state).	✓	Release buttons.
RELEASE SHOCK	• Discharge switch(es) closed when pressing charge button. • Discharge button pressed before defib reached ready state.	✓	• Release shock button. • Check paddles. • Replace controls board.
REMOVE SYNC	Analyze button pressed, or no heart rate detected while in Defib Sync mode.	✓	
REPEAT NIBP MEAS	• The unit exceeded the maximum number of inflation attempts. • The unit exceeded the 180-second measurement time limit.	✓	• Check cuff and hose. • Repeat NIBP measurement.
REPLACE BATTERY	Battery voltage is less than absolute minimum. Shutdown imminent.	✓	Replace with charged battery.
REPORT FULL	Summary report memory full.	✓	Erase summary report.
RETRY ANALYSIS	Advisory message in conjunction with noisy ECG. Analysis halted.	✓	
RPT NO DISK	Internal disk is not formatted and cannot be formatted.		

Error Message	Explanation	User Advisory	Technical Action
SELECT 30J FOR TEST	Attempt to run a self test at an energy other than 30J.	✓	
SELECT ASYNC PACE	User is prompted to select Async pacing, since the PD module cannot detect sync pulses.	✓	
SELECT DEFIB MODE	Analyze button pressed in pace or monitor mode.	✓	Turn main selector knob to Defib/ON.
SELECT LIMB LEADS	Paddles or augmented ECG leads selected when continuous analysis active or started.	✓	Select limb leads I, II, III or MFE.
SELECT PADS	ECG lead (non-MFE Pads) selected when ANALYZE pressed.	✓	
SET CLOCK	Real time clock failure: invalid date or time.	✓	• Set time and date information. • Verify that the internal lithium battery has been replaced within the last 5 years. Contact ZOLL Technical Service Department for assistance.
SET PACE MA	Multiple copy errors are the product of intended software or memory errors. If error reoccurs other than on entering pace the first time or after more than 10 minutes in other mode, the unit could be broken.	✓	Set pace current. If broken, replace system board.
SHOCK ADVISED	Advisory message when Analysis finds a shockable rhythm. Followed by PRESS SHOCK in Manual Advisory Defib with auto-charge enabled or in Auto Defib mode, or by PRESS CHARGE in Manual Advisory Defib with auto-charge disabled.	✓	
SPO2 AMBIENT LIGHT	Ambient light is too bright.		• Shield sensor from ambient light. • Replace sensor. • Replace SpO_2 module

Error Message	Explanation	User Advisory	Technical Action
SPO2 COMM ERROR	No transmissions from SpO_2 unit received. Communication error or no communication from SpO_2 module.		Replace SpO_2 module and/or system board.
SPO2 PULSE SEARCH	Pulse search in progress.	✓	
STAND CLEAR	(Manual Advisory Defib with auto-charge enabled or Semi-Auto Mode Defib) User pressed Analyze or an analysis was started automatically as part of the rescue protocol. Patient rhythm is being analyzed.	✓	
SUMMARY TIMEOUT	Summary report timeout error.		
SYNC DEFIB DISABLED	Sync mode active when analyze pressed in defib.	✓	
SYSTEM FAULT 210	System task have not been activated for 500 ms – ECG control.		Replace digital board.
SYSTEM FAULT 211	System task have not been activated for 500 ms – Defib.		Replace digital board.
SYSTEM FAULT 212	System task have not been activated for 500 ms – Pace.		Replace digital board.
SYSTEM FAULT 212	System task have not been activated for 500 ms – User Interface.		Replace digital board.
SYSTEM FAULT 214	System task have not been activated for 500 ms – Display.		Replace digital board.
SYSTEM FAULT 215	System task have not been activated for 500 ms – Not used.		Replace digital board.
SYSTEM FAULT 36	Filtered sum of all the supply voltages is out of range.		Replace analog board or digital board.
SYSTEM FAULT 37	1/2 scale reference voltage is out of range.		Replace analog board or PD engine.
SYSTEM FAULT 38	Failure to shutdown after "shutdown order" is written to the RTC.		Replace digital board.

Error Message	Explanation	User Advisory	Technical Action
TEST FAILED	30J defib self-test failed.	✓	Replace universal cable, paddles or high voltage module, capacitor, and/or system board.
TRANSFERRING DATA	Transferring data message.	✓	
USE PADDLE DISCHG	Defibrillator is charged and front-panel discharge button pressed when either external paddles or internal spoons with discharge buttons are connected.	✓	
USE PADS TO PACE	MFE accessory other than Pads detected in Pace mode.	✓	
USER SETUP REQ.	Both copies of configuration data are bad, or software with a configuration rev older than the current one was loaded.	✓	Reconfigure unit.
VF ALARMS OFF	Alarms enabled in Pace Mode or when Continuous Analysis active or started in manual mode but the current lead is not Pads, Lead I, Lead II, or Lead III. Also displayed if the Alarm button is pressed but the Heart Rate alarm is disabled.	✓	
ZERO CO2 ADAPTER	Negative CO_2 detected. May be caused by a sensor that was zeroed with CO_2 in the airway, or by an optical blockage of the airway adapter.	✓	Check the airway adapter and clean if necessary. Perform a mainstream airway adapter zero as described in “Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter.”
ZERO DONE	The sensor/adapter zero is finished.	✓	No action required.

Error Message	Explanation	User Advisory	Technical Action
ZEROING CO2 ADAPTER	Adapter zeroing is in progress.	✓	Wait for the adapter zeroing to finish.
ZERO FAILED	The zero operation did not complete successfully.	✓	Clear the occlusion, remove any source of CO_2, and try zeroing again. If problem persists, contact ZOLL Technical Support.

Chapter 3
Disassembly Procedures

This chapter provides step by step instructions on how to disassemble the ZOLL R Series by properly disconnecting and removing its major modules and sub-assemblies. To reassemble the R Series, these instructions can be followed in reverse order.

Where relevant, this section also contains notes, warning statements, and caution statements intended to inform the service technician of the potential for personal injury and/or harm to the device, if improperly handled. Ensure that you have read and understand all warning and caution statements before attempting to disassemble or reassemble the device.

Required Equipment

- #1 Phillips head screwdriver
- #2 Phillips head screwdriver
- 9/64” hex head screwdriver
- ESD-safe spudger tool
- Needlenose pliers
- 1/4” nut driver
- 3M Scotch-Weld Hot Melt Adhesive 3779 TC Amber
- Capacitor discharge tool (PN: 9100-0174-TF)

Safety Precautions

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

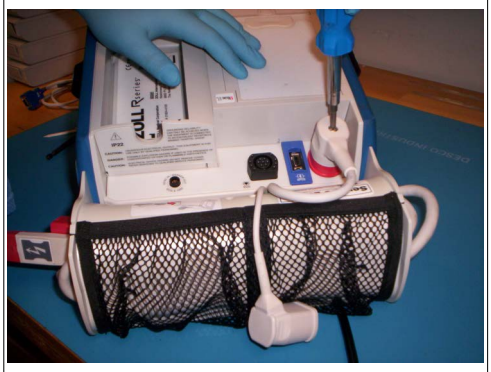
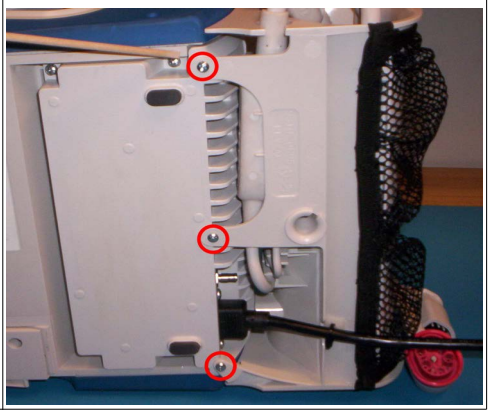
Caution Failure to follow documented instructions may result in damage to the device.

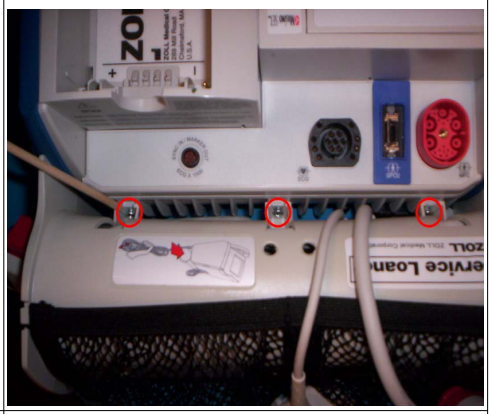
- Only properly trained technicians should service the unit.
- The unit can contain deadly voltages even if the unit is turned off.
- Make sure to discharge the unit before working with it.
- Make sure you take the necessary precautions when working with static sensitive units. For example, you must 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.
- Wear gloves to prevent skin oils from affecting the equipment.

Removing the Cable Caddy

Tools Required

- #2 Phillips head screwdriver

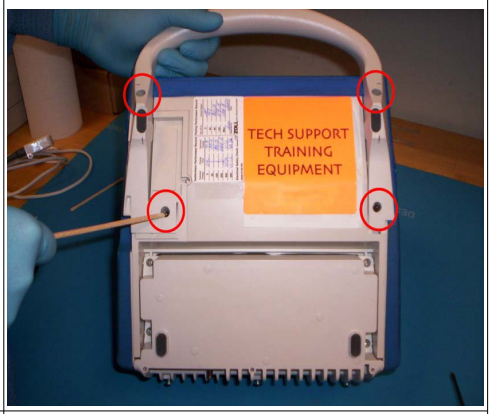
Step	Action	Image
1	Disconnect all cables from the R Series.	
2	On the underside of the R Series, locate the three (3) screws securing the cable caddy (shown circled in red). Using a screwdriver, completely remove these screws.	

Step	Action	Image
3	On the rear of the R Series, locate the three (3) screws securing the cable caddy (shown circled in red). Using a screwdriver, loosen these screws. **Note:** It is not necessary to remove the rear screws completely or to remove the mesh.	
4	Disconnect the AC line cord extension cable from the AC input receptacle when removing the cable caddy.	

Removing the Handle

Tools Required

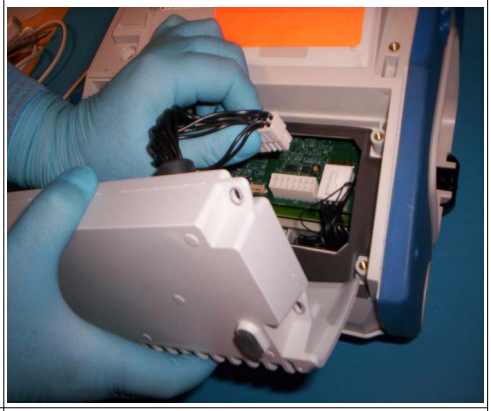
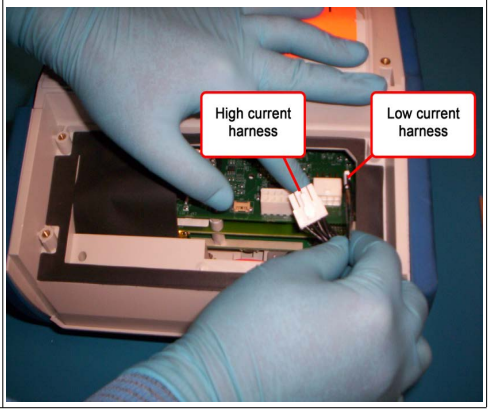
- Hex head screwdriver

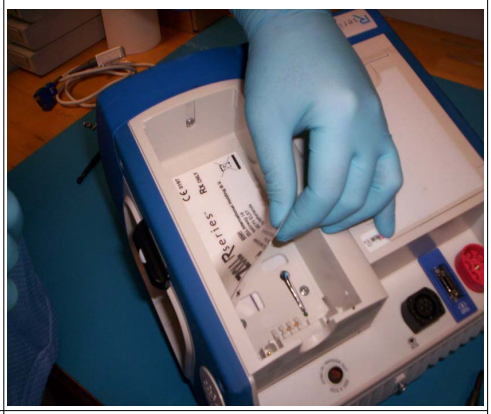
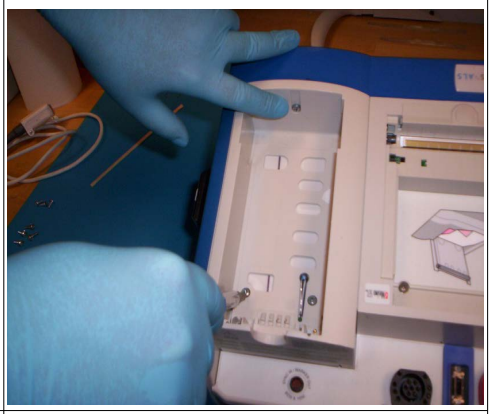
Step	Action	Image
1	Locate the four (4) hex screws securing the handle (circled in red). Using a hex head screwdriver, remove them.	
2	Lift the handle to remove.	

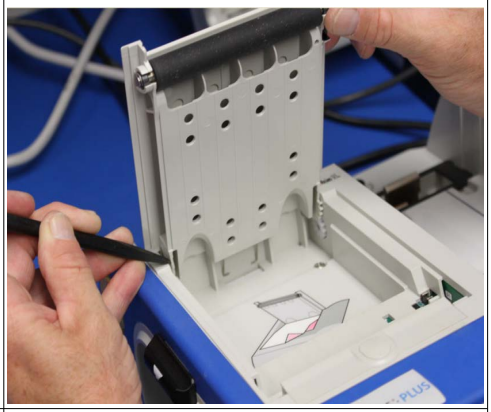
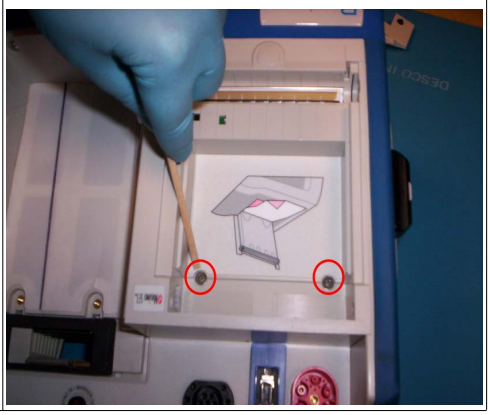
Removing the Recorder, AC Charger, and Battery Well

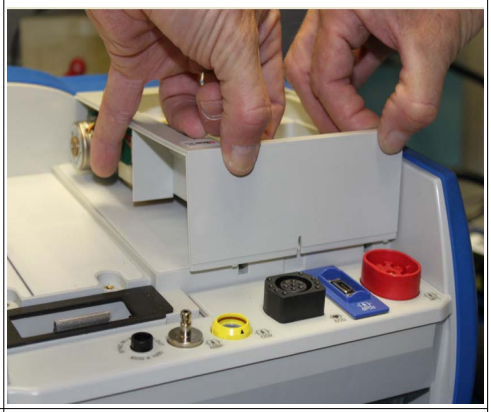
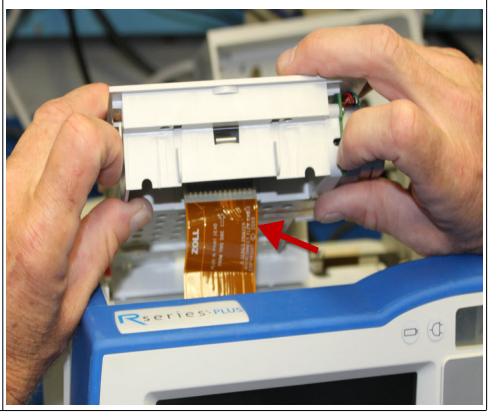
Tools Required

- #2 Phillips head screwdriver
- ESD-safe spudger tool

Step	Action	Image
1	Using a screwdriver, remove the four (4) screws securing the AC Charger assembly. **Note:** During reassembly, torque these screws to 10 in-lbs.	
2	Remove the AC Charger assembly from the chassis by lifting straight upward. Disconnect the cable connecting the charger to the PD Engine.	
3	If removing the battery well, disconnect the high and low current cables from the PD Engine	

Step	Action	Image
4	Remove the label within the battery well by peeling it, starting with the edge of the label nearest the rear of the R Series. **Note:** Upon reassembly, if the label adhesion is poor, it may be necessary to use a new label (PN: 9305-0901-01).	
5	Remove the three (3) screws securing the battery well. **Note:** During reassembly, torque these screws to 6 in-lbs.	
6	Lift the battery well from the front of the R Series, tilting it towards the rear. DO NOT disconnect the low and high current harnesses. Feed these harnesses up through the chassis to remove the battery well.	

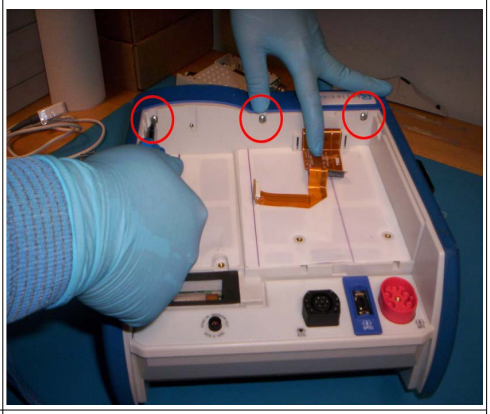
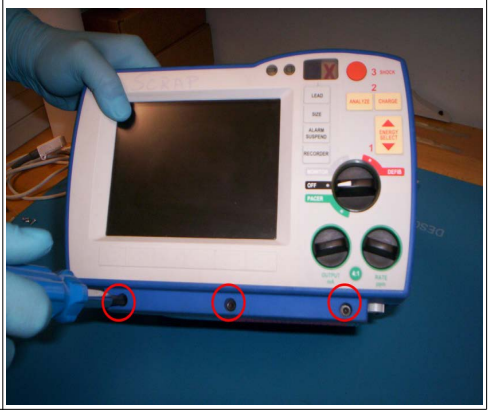
Step	Action	Image
7	Open the recorder door. Using an ESD-safe spudger tool, press inward on the recorder door hinge to release it.	
8	Using a screwdriver, remove the two (2) screws that secure the recorder tray. **Note:** During reassembly, torque these screws to 6 in-lbs.	

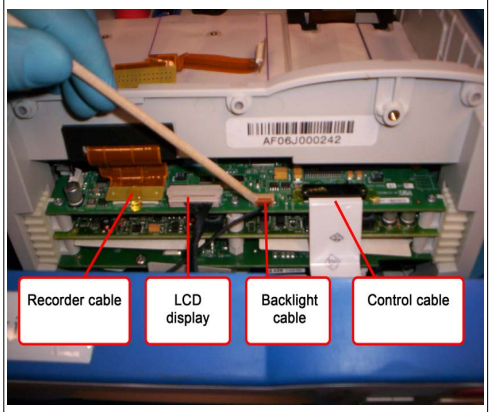
Step	Action	Image
9	Grip the edge of the recorder tray nearest the rear of the R Series, and lift upward to release it.	
10	Rotate the R Series so that the display is facing you. Lift upward on the paper tray to expose the cables. Disconnect the recorder interconnect cable from the print head and the motor/sensor board. **Note:** During reassembly, observe the labeling on the cable to verify you are connecting the cable correctly.	

Removing the Front Panel Assembly

Tools Required

- #2 Phillips head screwdriver
- Hex head screwdriver
- Needlenose pliers

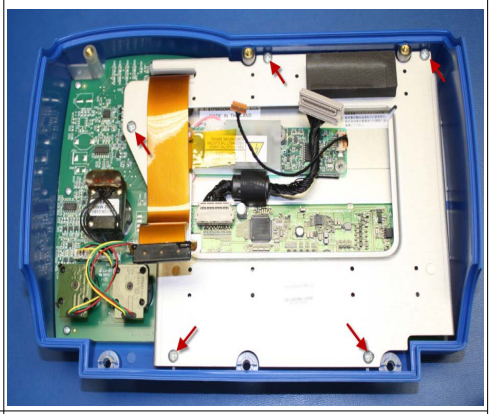
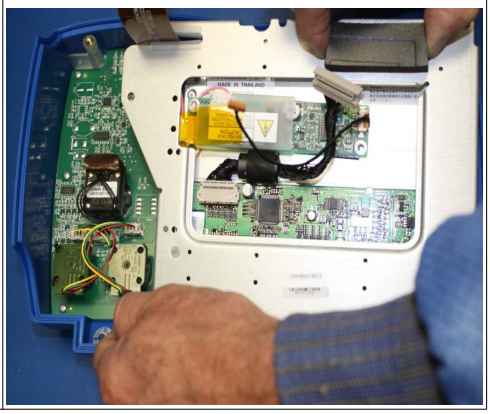
Step	Action	Image
1	Using a screwdriver, remove the three (3) screws from the top of the rear face of the Front Panel Assembly.	
2	Using a hex head screwdriver, remove the three (3) hex screws from the bottom of the Front Panel Assembly.	

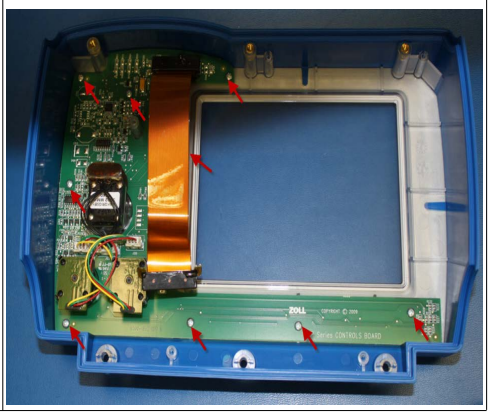
Step	Action	Image
3	Carefully tilt and lower the Front Panel Assembly as shown.	
4	Using needlenose pliers, carefully remove the hot melt glue from the recorder and controls cables. Then, carefully disconnect the four (4) cables shown (recorder cable, LCD display cable, backlight cable, controls cable). **Note:** During reassembly, reapply hot melt glue to the recorder cable and controls cable. Use 3M Scotch-Weld Hot Melt Adhesive 3779 TC Amber.	

Front Panel Disassembly

Tools Required

- #2 Phillips head screwdriver

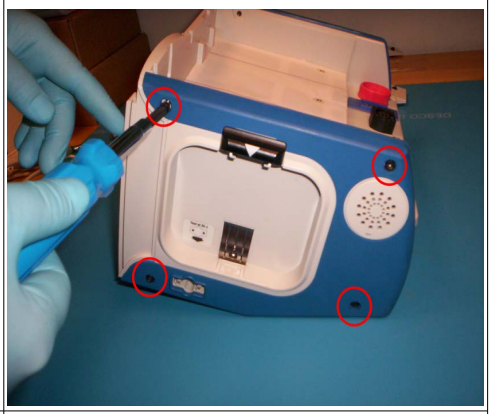
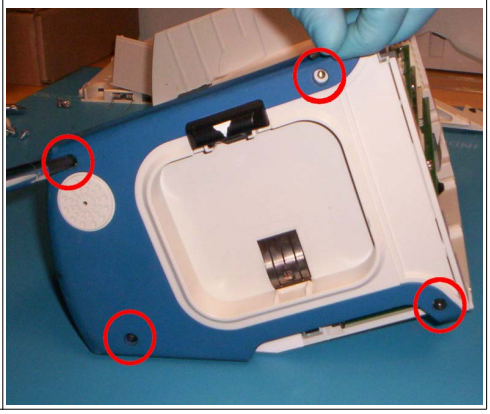
Step	Action	Image
1	Using a screwdriver, remove the five (5) screws securing the metal shield. **Note:** During reassembly, torque these screws to 6 in-lbs.	
2	Lift display assembly straight outward from the Front Panel.	

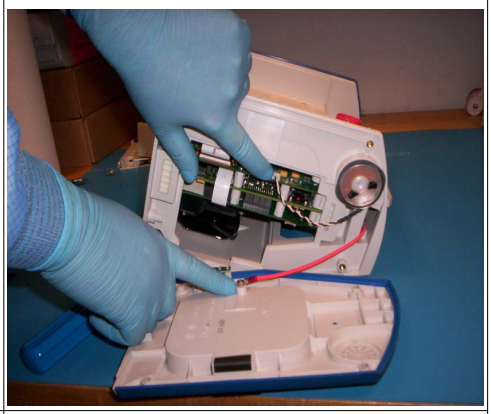
Step	Action	Image
3	Remove the main selector and pacer knobs by pulling them straight outward, then remove the nuts securing them to the Front Panel.	
4	Using a screwdriver, remove the nine (9) screws securing the control board to the Front Panel. **Note:** During reassembly, torque these screws to 6 in-lbs.	

Removing the Side Panels

Tools Required

- Hex head screwdriver

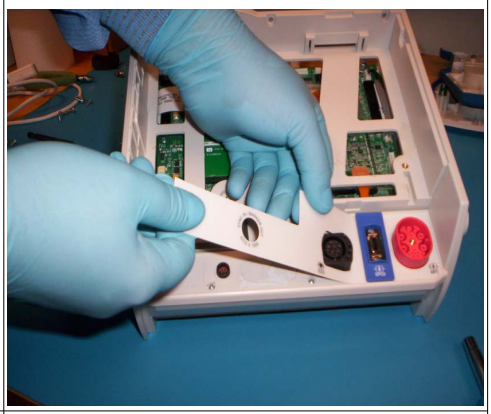
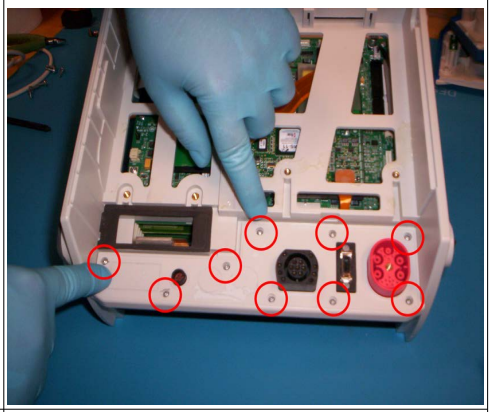
Step	Action	Image
1	Using a hex head screwdriver, remove the four (4) hex screws from the right side panel. **Note:** During reassembly, torque these screws to 10 in-lbs.	
2	Using a hex head screwdriver, remove the four (4) hex screws from the left side panel. **Note:** During reassembly, torque these screws to 10 in-lbs.	

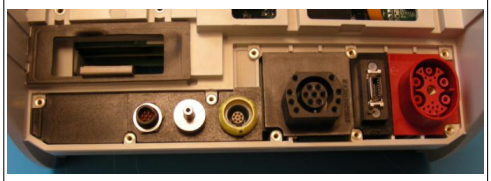
Step	Action	Image
3	Remove the right side panel by pulling it outward toward you. The speaker may or may not come off with the panel. Disconnect the speaker from the Digital System Board by pulling straight outward. Remove the shorting wire from the side panel by taking off the nut. **Note:** During reassembly, torque the nut to 6 in-lbs.	
4	Remove the left side panel by pulling it outward toward you. Remove the shorting wire from the side panel by taking off the nut. **Note:** During reassembly, torque the nut to 6 in-lbs.	

Removing the Connector Panel and Bezel

Tools Required

- #1 Phillips head screwdriver

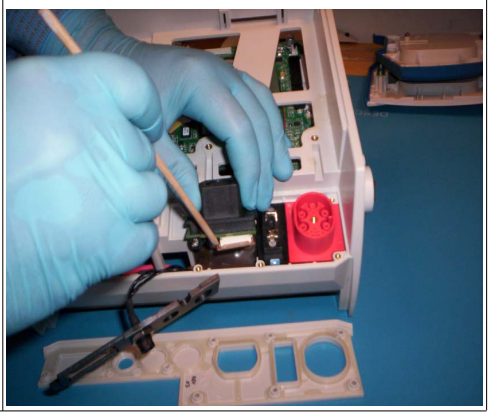
Step	Action	Image
1	Remove the label covering the Connector Panel bezel. **Note:** It may be necessary to use a new label if the adhesion is poor or the label is damaged upon reassembly.	
2	Using a screwdriver, remove the nine (9) screws securing the Connector Panel bezel. **Note:** During reassembly, torque these screws to 4 in-lbs.	
3	Remove the Connector Panel by lifting straight upward. **Note:** Depending on the options, the RS232 connector may be attached to the panel. In that case, the panel can be draped over the rear of the unit.	

Step	Action	Image
	Note: Pictured is the Connector Panel with the EtCO2 and NIBP options.	
	Note: One or both side panels and/or the Front Panel may need to be removed in order to disconnect cabling from some of the connectors located on the rear panel.	

Removing the ECG Input Connector

Tools Required

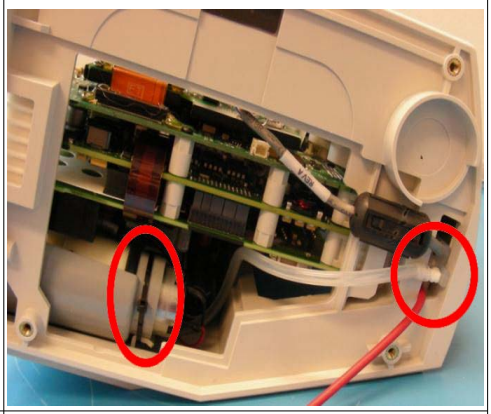
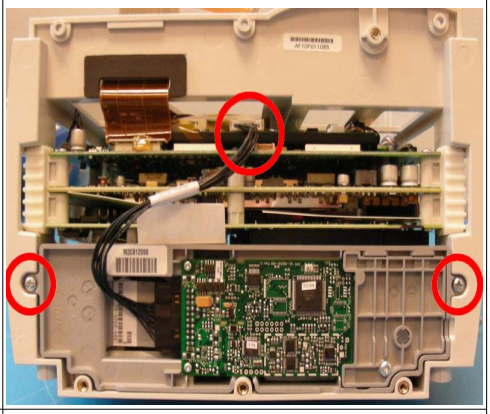
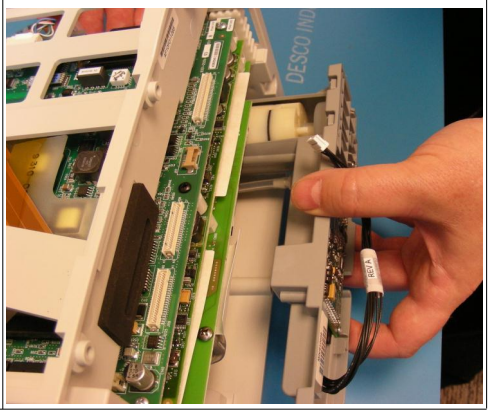
- ESD-safe spudger tool

Step	Action	Image
1	Carefully lift the ECG Connector by tilting the rear of the connector up first. Then carefully remove the cable from the connector as shown using an ESD-safe spudger tool. Remove the connector from the chassis. **Note:** After removing all connectors, clean them with compressed air.	

Removing the NIBP Assembly

Tools Required

- ESD-safe spudger tool

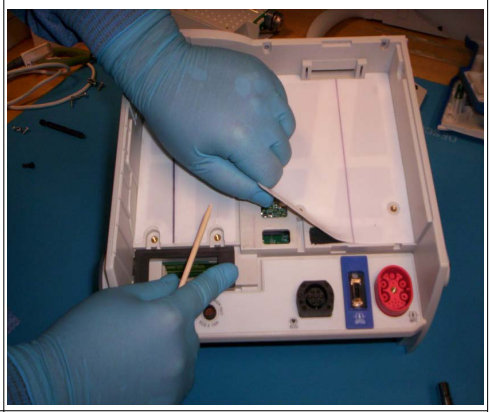
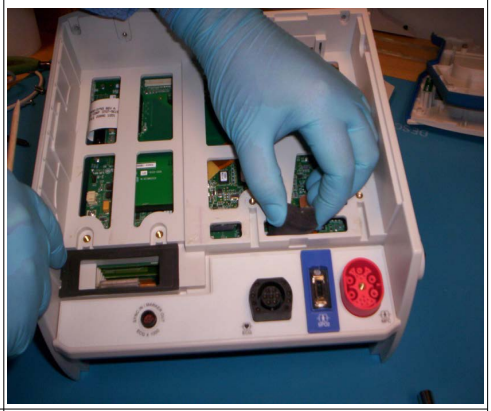
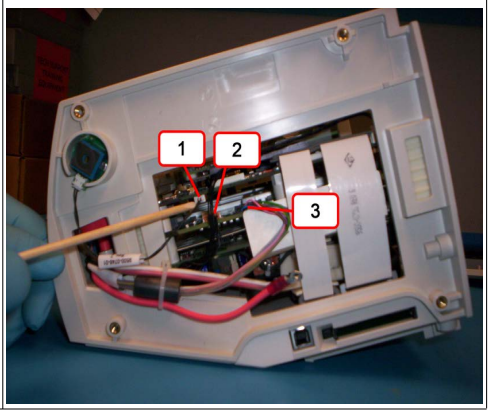
Step	Action	Image
1	Disconnect the hose from the manifold and cut the cable tie securing the pump to the chassis. **Note:** When reassembling, ensure NIBP tubing is not routed between pump wiring. Secure the NIBP bracket to the anchor with a cable tie.	
2	Disconnect the cable from the NIBP assembly from the parameter power supply by pushing down on the latch at the top of the connector. Remove the two (2) screws securing the NIBP assembly to the chassis. **Note:** During reassembly, torque these screws to 6 in-lbs.	
3	Slide the NIBP assembly out of the chassis.	

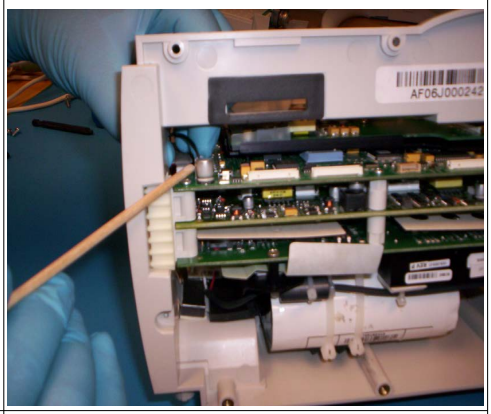
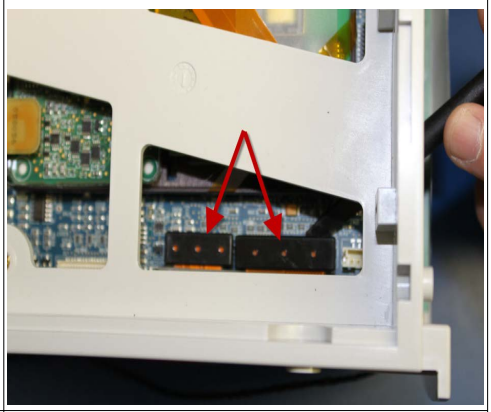
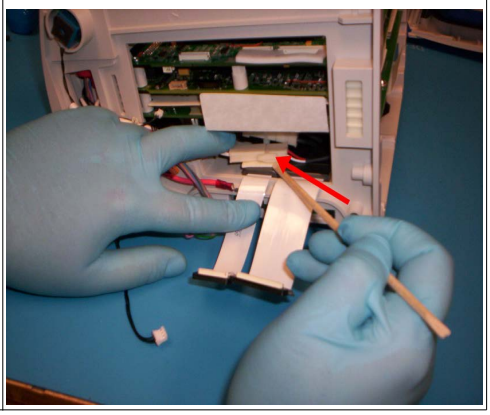
Removing the System Brick Assembly

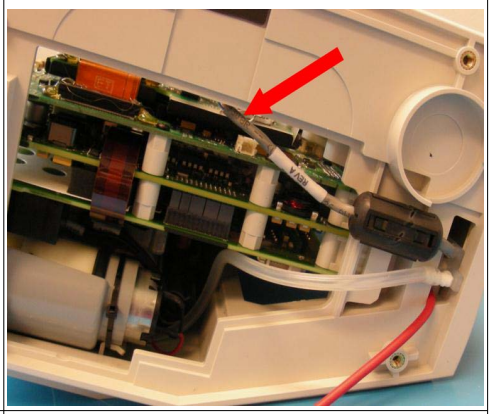
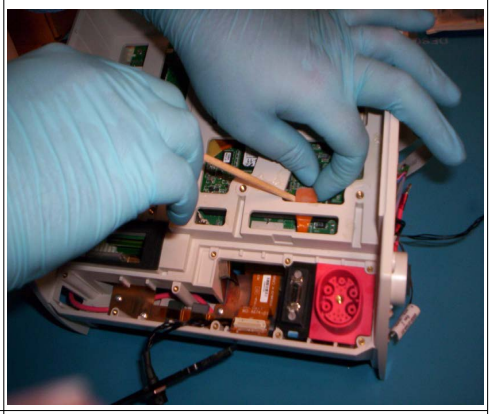
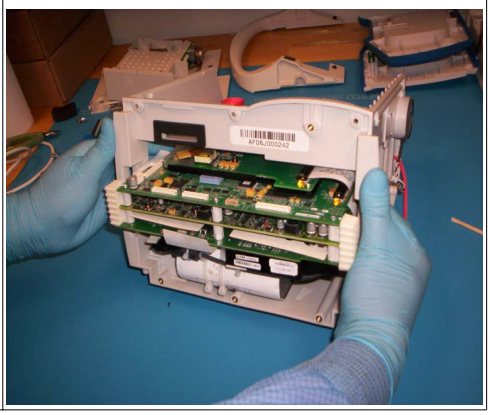
WARNING! SHOCK HAZARD! TAKE THE NECESSARY PRECAUTIONS TO GUARD AGAINST SHOCK OR INJURY BEFORE PROCEEDING.

Tools Required

- ESD-safe spudger tool

Step	Action	Image
1	Remove the printer housing barrier from the chassis. **Note:** During reassembly, the barrier may be reused if the adhesive side is not contaminated.	
2	Remove the ECG retainer pad. **Note:** When reinserting the pad during reassembly, push it down until it touches the ECG cable connector.	
3	Carefully disconnect the speaker harness (1), the sync cable (2), and the patient impedance cable (3). **Note:** Disconnect the speaker on the opposite side of the brick assembly if you have not done so already.	

Step	Action	Image
4	Carefully disconnect the sync cable by pulling straight upward from the top.	
5	From the top of the R Series, disconnect the USB and compact flash cables by lifting the connectors straight upward away from the board.	
6	Carefully pull back the USB and compact flash cables to gain access to the MFC cable. Disconnect the MFC cable.	

Step	Action	Image
7	If applicable, disconnect the $EtCO_2$ cable from the parameter power supply by pushing down on the connector latch.	
8	Carefully pull the brick assembly out slightly through the front; disconnect the SpO_2 connector cable.	
9	After verifying that all cables are disconnected from the system brick, slide the entire system brick out of the front of the chassis.	

Disassembling the System Brick Assembly

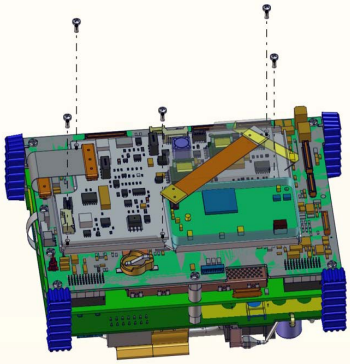
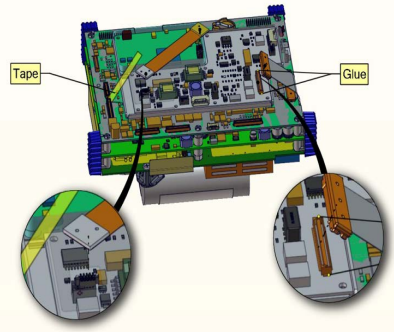
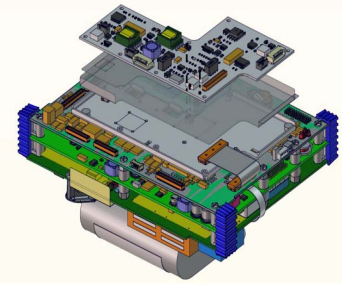
WARNING! SHOCK HAZARD! TAKE THE NECESSARY PRECAUTIONS TO GUARD AGAINST SHOCK OR INJURY BEFORE PROCEEDING.

The system brick assembly consists of three primary boards attached together. Units equipped with SpO2 and/or EtCO2 and NIBP will have two additional boards.

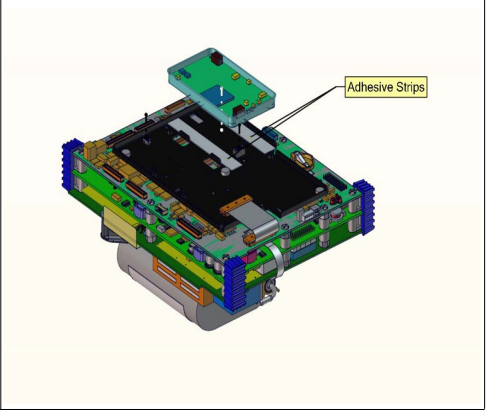
- Top: Digital system board (SpO2 module and isolated power supply sits on digital board)
- Middle: Analog system board
- Bottom: Pace defibrillator engine

Caution Use caution when separating the three boards to prevent the EMI suppression plates from scattering.

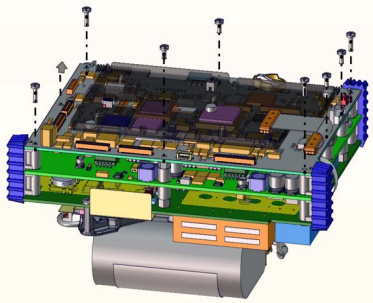
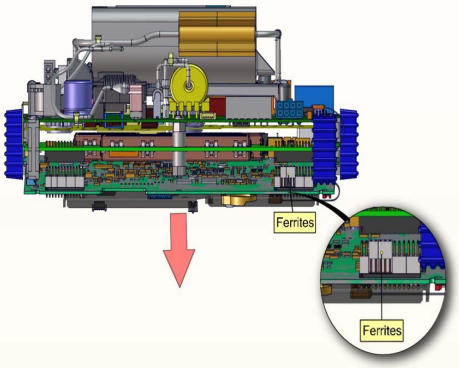
Removing Isolated Power Supply

Step	Action	Image
1	Using a screwdriver, remove the five (5) screws holding the isolated power supply. **Note:** During reassembly, torque these screws to 4 in-lbs.	
2	Peel back glue from connector pictured, and disconnect cable by pulling straight upward. **Note:** During reassembly, reapply glue to each side of the connector.	
3	Lift the isolated power supply board and shield out of tray.	

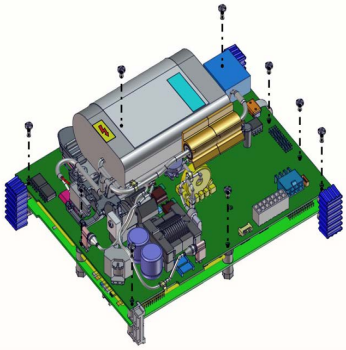
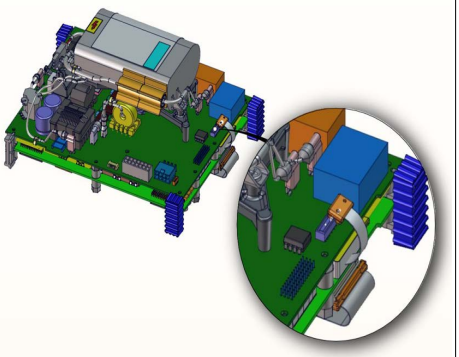
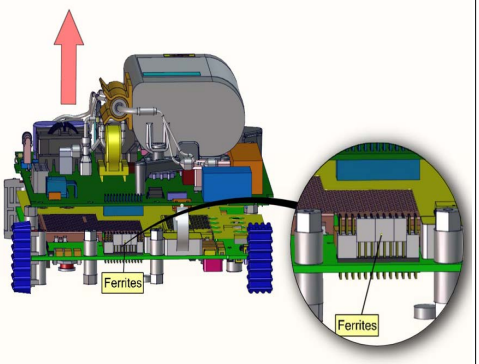
Removing the SpO_2 Module

Step	Action	Image
1	Using a prying tool, lift upward on the board to release the adhesive (the SpO_2 module is held in place with adhesive strips). **Note:** If the plastic isolator tray (PN 9310-0889) is damaged during reassembly, it should be replaced.	

Removing the Digital Board

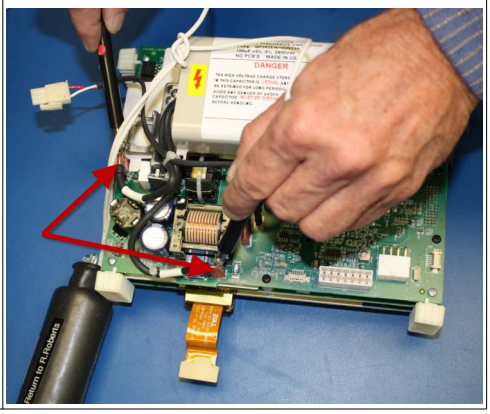
Step	Action	Image
1	Using a screwdriver, remove the nine (9) screws holding the digital board to the assembly. **Note:** During reassembly, inspect standoffs and corner post to verify they are not stripped. Replace them if necessary. Torque four (4) corner screws (longer) to 6 in-lbs and the five (5) inner screws to 4 in-lbs.	
2	Tilt the assembly up, and carefully pull the board toward you to disconnect it from the connectors. **Note:** Since the ferrite beads on the connector are loose, ensure they are in place during reassembly.	

Removing the Pace Defibrillator (PD) Engine

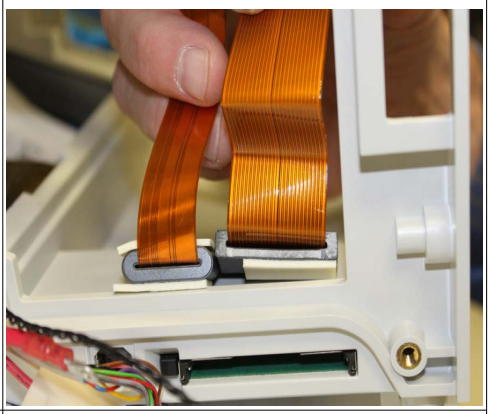
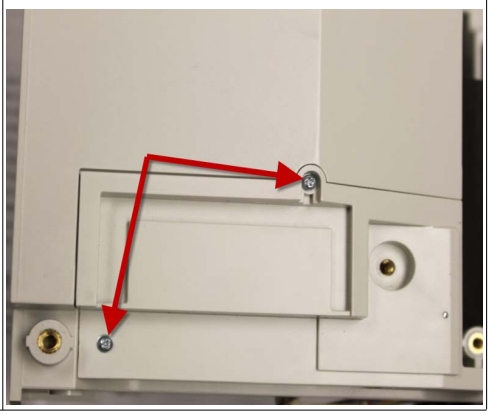
Step	Action	Image
1	Using a screwdriver, remove the nine (9) screws holding the PD Engine to the assembly. **Note:** During reassembly, inspect standoffs and corner post to verify they are not stripped. Replace them if necessary. Torque four (4) corner screws (longer) to 6 in-lbs and the five (5) inner screws to 4 in-lbs.	
2	Carefully remove the cable from the PD board using a gentle rocking motion to unseat the connector from the board.	
3	Lift upward on the PD board to disconnect it from the analog board. **Note:** Since the ferrite beads on the connector are loose, ensure they are in place during reassembly.	

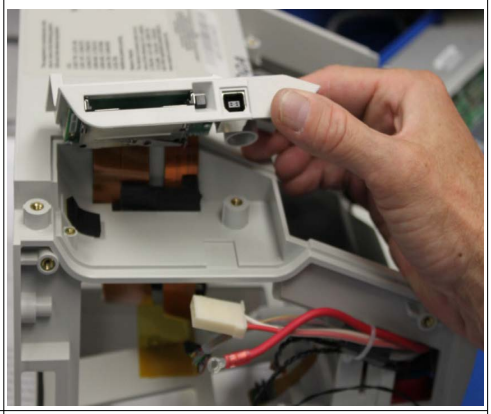
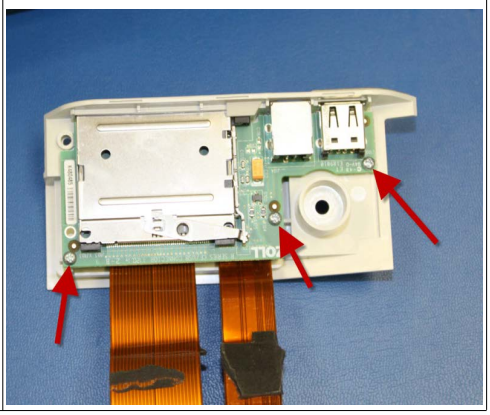
Discharging the Capacitor

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

Step	Action	Image
1	While capacitor is connected to the PD Engine assembly, discharge the capacitor by bleeding out the excess voltage using a resistor with values of approximately 5k ohms, 25 watts for 10-20 seconds. Apply the resistor across the terminals on the board. Measure the voltage on the capacitor terminals to verify that capacitor is discharged.	

Removing the Communication Module

Step	Action	Image
1	Peel back the foam pads from the housing.	
2	Using a screwdriver, remove the two (2) screws from the bottom of the housing. **Note:** During reassembly, torque these screws to 4 in-lbs.	

Step	Action	Image
3	Remove the foam pads from the cables and ferrite beads. Lift module upwards and route the cables through the slot in the housing. **Note:** During reassembly, reapply foam pieces and secure them to the housing.	
4	Using a screwdriver, remove the three (3) screws and slide the board back to remove. **Note:** During reassembly, torque these screws to 2 in-lbs.	

Chapter 4
Replacement Parts

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

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:

- ZOLL R Series device model and serial number
- Field Replaceable unit part number
- Description of the replacement part
- Description of problem

To order by mail from ZOLL Medical Corporation, address your request to:

ZOLL Medical Corporation

269 Mill Road

Chelmsford, MA. 01824-4105

Attention: Technical Service Department

1-978-421-9655; 1-800-348-9011; Fax: 1-978-421-0010

Note: ZOLL reserves the right to substitute different parts to reflect modifications and improvements in ZOLL R Series circuitry and design.

List of Replacement Parts

Item numbers refer to the callouts in the diagrams immediately following the table below. For the System Brick Assembly see page 4-41.

Part Number	Description	Item number
Main Housing		
9310-2787-99	Rework, Main Housing	1
9301-001525-01	Assembly, PCB, PCB, Beeper Connector	19
9330-0750	Mount, Speaker, Beeper, Foam	18
9161-0034	Gasket, Beeper, Foam	17
9500-0760	Assembly, Cable, Paddle Shorting	12
9161-0025	Gasket, Printer, Flex Cable	4
9161-0026	Gasket, Battery Trough to Housing	2
9500-0746-01	Cable, Assembly, Beeper	16
9161-0302	Gasket, Paddle Latch	3
9320-0748	Panel, Connector, Ground Plane	10
9320-0751	Plane, Ground, Battery Board	11
0163-0401	Scr. PPH. #4.x 0.312". STL./ZNC.Hi/Lo	8
9161-0027	Gasket, Compact Flash to Housing	5
9330-0769	Pad, ESD, ECG Connector	14
9330-0756	Pad, ESD, Battery PCB	9
9330-0738	Pad, .70 X .50, rubber	6
9305-002090-01	Label, regulatory, UL, Large SN window	7
0140-0201	Ferrite Core Flat Cable Type	13
9310-0894	Isolator, ECG	15
Back Panel		
0140-0202	Ferrite Core Flat Cable Type	100
0162-0033	Washer.Ribbed Lock.M14. 15mm ID.x 22mm OD.x 2mm.ZINC.	25
0163-0029	Washer.Lock Int.7/16.0.456"ID.0.765"OD.0.036"THK.SS	28
0163-0286	Scr. #2-56, MCH, 5/16", PNH, PHL, STL, Int	21
0163-0401	Scr. PPH. #4.x 0.312".STL./ZNC.Hi/Lo	8
0163-2500	Nut.Hex.7/16 - 24 Unf.Chrome Plated Brass Panel Nut	26
0501-0001	Ty-Rap cable tie STD 18 LB .093W X 3.62 L	99
1009-0902-01	Assembly, Communications Module	20
1009-0929-01	Assembly, Cable Organizer	33
1009-0930-01	Assembly, NIBP Fitting-O-ring	30
9150-0503	Connector, MFC, Assembly	31

Part Number	Description	Item number
9161-0032	Gasket, Compact Flash, USDB	23
9310-2786	Connector Panel	29
9330-0717	Mount, Adhesive, Color inverter PCB	22
9500-001837	Assembly, Cable, SYNC, IN/OUT, ECG, RS232	27
9500-0902	Cable, Isolated Power Supply to $EtCO_2$	24
9500-0991	Assembly, SpO_2, internal connector	32
PCB Brick Assembly		
Complete		
0140-5622	Mag.Round Cable Core assembly, Ferrite	90
0163-0286	Scr. #2-56, MCH, 5/16", PNH, PHL, STL, Int	21
0163-1231	Scr. PHH PNH. #6.0.500" Lg.STL/ZN.ZI.Hi/Lo	88
0501-0002	Cable tie, 8" X 0.1" Black UV	95
1009-0901-01	Assembly, System Brick	85
1009-0901-02	Assembly, Options, System Brick	85
1009-000943-01	Assembly, System Brick, ALS/BLS, no physiological monitoring	85
1009-000942-04	Assembly, Options, System Brick, ALS/BLS, SpO_2	85
1009-000942-05	Assembly, System Brick, Nellcor	85
1009-000943-06	Assembly, Options, System Brick, SpO_2/$EtCO_2$/ NIBP	85
1009-000943-07	Assembly, Options, System Brick, Nellcor, SpO_2/$EtCO_2$/ NIBP	85
1009-000943-03	Assembly, Options, System Brick, $EtCO_2$	85
1009-0928-01	Assembly, Chassis, NIBP option	87
1009-0931	Assembly, Anchor, NIBP Pump, VHB Tape	86
9301-001526-01	Assembly, PCB, ECG Interconnect, Flex Cable	93
9301-002512-02	Assembly, PCB, ECG Input Connector, 3/5 Lead	92
9310-2789	Connector Panel Bezel	91
9330-0664	Retainer Pad, ECG	94
9330-0933	Strip, VHB, CF/USB	96
9330-0935	Pad, VHB, CF/USB	97
9330-0944	Foam, Tape, VHB 4952, 1.25 X .50	89
9500-0770	Cable Assembly, Hi/Lo Current, Battery to P/D Engine	98
Sub-assembly		
1009-000948-01	Assembly, Kit, Digital Board, No options ALS/BLS	101
1009-000948-04	Assembly, Kit, SpO_2, Digital Board, ALS/Plus	101
1009-000948-05	Assembly, Kit, Digital Board, ALS/Plus, Nellcor	101

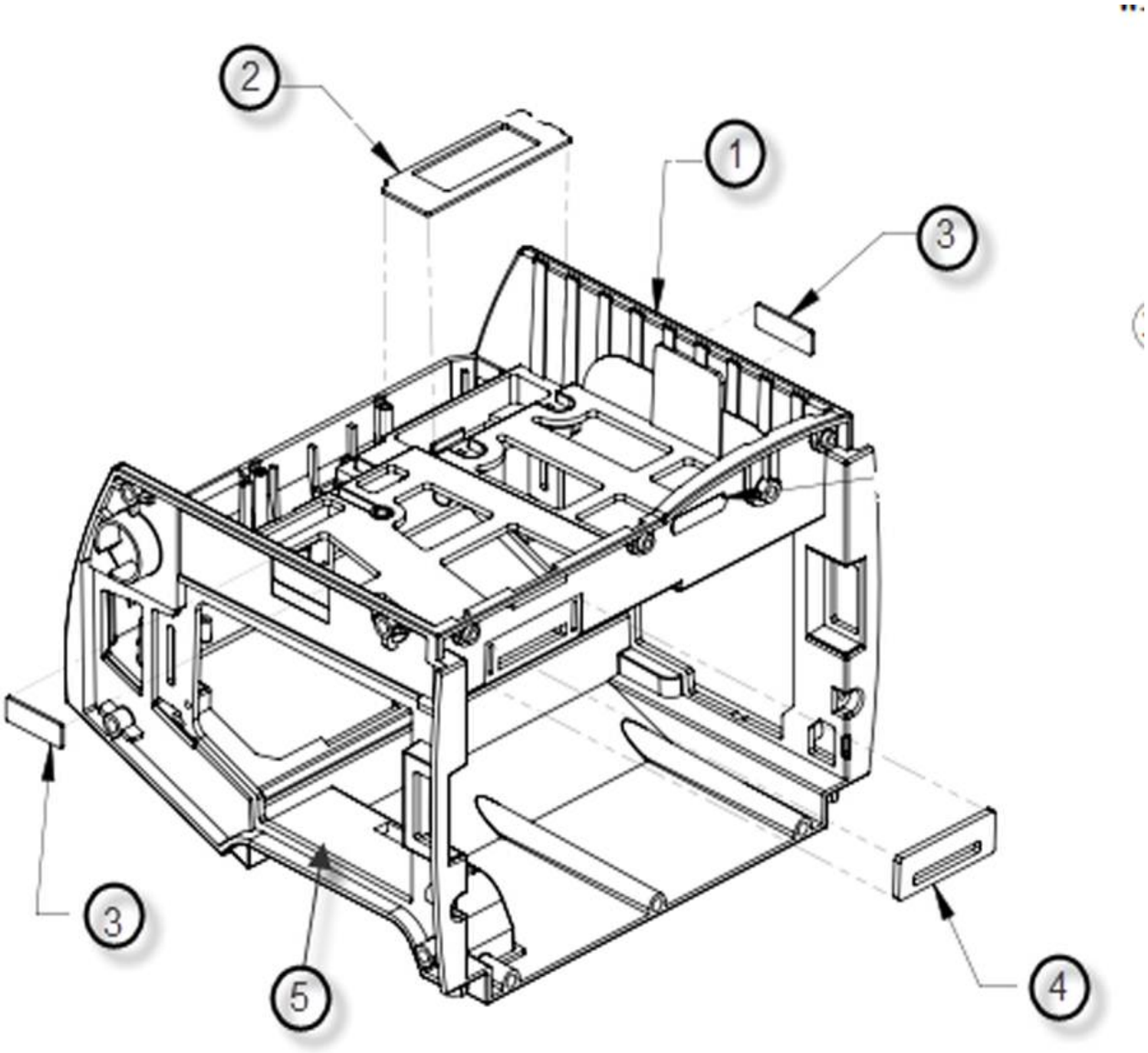
Part Number	Description	Item number
1009-000948-06	Assembly, Kit, Digital Board, SpO_2/$EtCO_2$/NIBP	101
1009-000948-07	Assembly, Kit, Digital Board, SpO_2/$EtCO_2$/NIBP, Nellcor	101
1009-000948-03	Assembly, Kit, $EtCO_2$, Digital Board	101
1009-0910-02	Assembly, Shielded Analog System Board, 3/5 Lead	102
1009-0909-01	Assembly, PD Engine, Capacitor	103
1009-0926-01	Assembly, PD Engine, Capacitor	103
SpO_2 and $EtCO_2$ sub-assembly		
1009-0899-06	Assembly, SpO_2	104
1009-0899-07	Assembly, SpO_2, Nellcor	104
1009-000944-11	Assembly, SpO_2/$EtCO_2$/NIBP	104
1009-000944-12	Assembly, SpO_2/$EtCO_2$/NIBP, Nellcor	104
1009-000944-10	Assembly, $EtCO_2$	104
9330-0843	Thermal Pad, 1.0 x1.0	105
9330-0842	Thermal Pad, .75 x.75	106
0163-0102	Scr. #6-32, MCH,5/16", PNH,PHL,SST, Int	107
Charger and Side Panel		
0163-0416	Scr. #6-32, MCH, 7/16", PNH, PHL, STL, Ext	36
1009-001900-01	Assembly, AC Charger	35
9161-0024	Gasket, Charger to Housing	34
9310-2784-01	Cap, End, Right, Assembly	37
9310-2784-02	Cap, End, Left, Assembly	38
0163-0353	Scr. 8-32 X 7/16" SHCS SS Pass Black	39
0190-0100	Spring, Compression.0.210"X.0.375" SS	40
9320-0747	Spring, Paddle, Grounding	43
9310-0785	Latch, Paddle	41
9310-1515	Retainer, Latch, Paddle Release	42
0163-0401	Scr. PPH.#4.x 0.312".STL./ZNC.Hi/Lo	8
0163-0415	Scr. #4-40, MCH, 9/16, Flt, PHL, SST	44
9161-0304	Gasket, Test Port	45
9300-001530	PCB, Defib Test Port	46
9330-0742	Pin, Receptacle, Test Port	47
0163-2502	Scr. #2-56, MCH, 1/4", PNH, PHL, STL	48
0163-0285	Nut.KEPS.4-40.SS	110
9330-0743	Housing, Battery, Barrier	108
9330-0744	Housing, Printer, Barrier	109

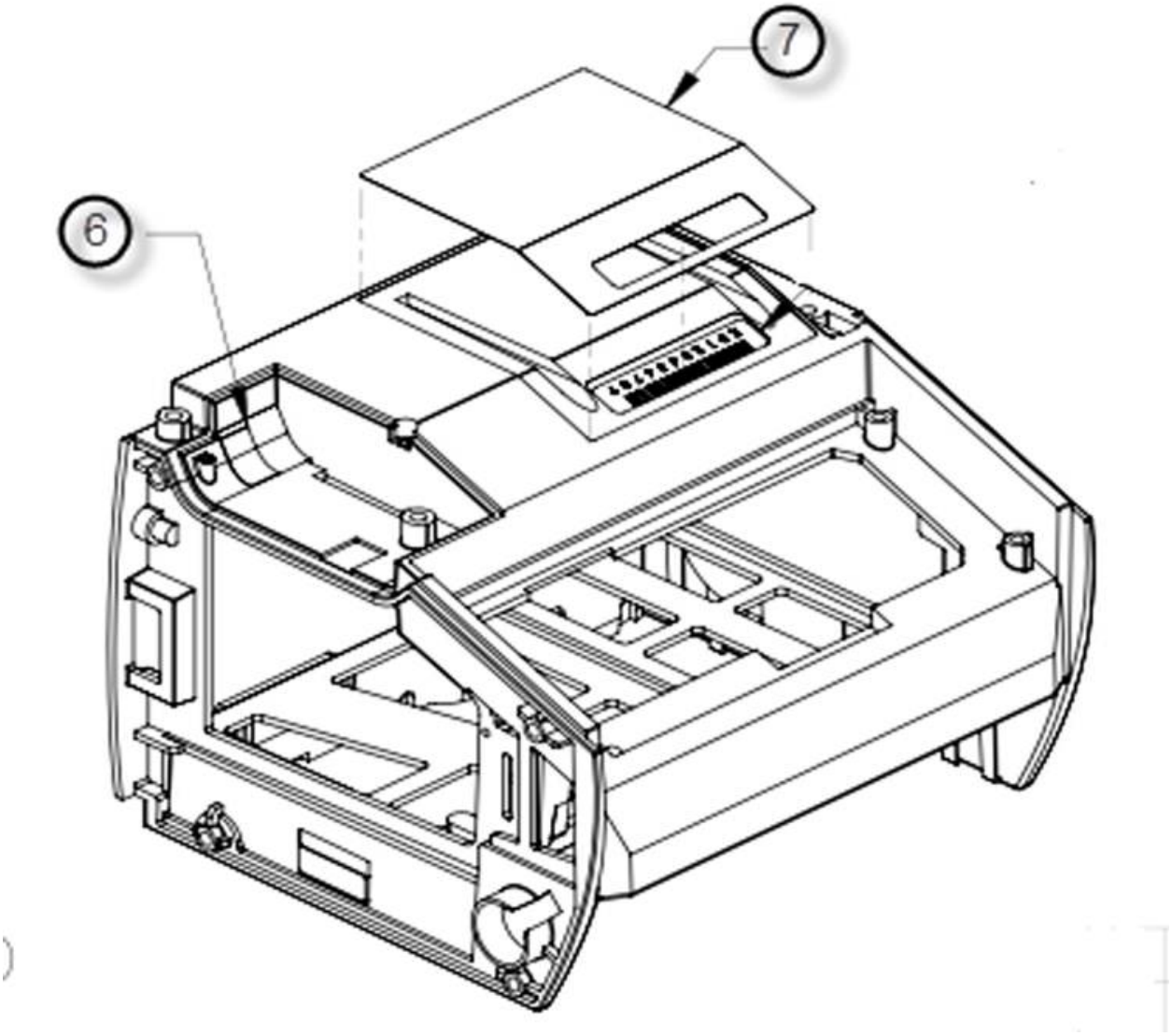
Part Number	Description	Item number
9142-000005	Assembly, Speaker	111
9330-0943	Foam, Silicone, F12, 1.50 X .80 X .12	112
Front Panel Housing		
0163-0353	Scr. 8-32 X 7/16"..SHCS SS Pass, Black	39
0163-0416	Scr. #6-32, MCH, 7/16", PNH, PHL, STL, Ext.	36
1009-000951-01	Assembly, Display Panel	50
1009-0904-03	Assembly, Display Panel, ALS, $EtCO_2$, NIBP	50
1009-0904-04	Assembly, Display Panel, BLS, NIBP	50
1009-0904-05	Assembly, Display Panel, ALS, $EtCO_2$	50
1009-0904-06	Assembly, Display Panel, BLS	50
1009-0933-01	Assembly, Handle	52
9302-001524-01	Assembly, Printer Interconnect Flex Cable	51
0155-0001	Magnetic.Sphere.Neodimium.0.187" dia	71
0163-2504	Scr. PPH.#2-32.X 0.312".STL.ZN.Hi/Lo	65
1009-001920-01	Assembly, Inner Frame BLS	61
1009-0923-01	Assembly, Pacer Door BLS	72
1009-0924-01	Assembly, Main Frame, VHB, adhesive	74
1009-0925-01	Assembly, Main Knob, BLS	63
1009-0936-01	Assembly, Pacer/Knob/O-Ring	54
9310-0790-01	Knob, with Spring, Main	53
9310-0803	Ring, Pacer	55
9310-0955	Filler, Pace	56
9310-0969	Pacer Knob, BLS	64
9310-0971	Knob, Index Ring BLS	62
9310-0977	Main Panel, No Pacer, BLS	66
9310-0986-01	Keypad, Front Panel, BLS/Plus with NIBP	60
9310-0994-01	Keypad Tiles, Monitor, BLS	69
9310-0994-02	Keypad Tiles, Defib, BLS	67
9310-0994-03	Keypad Tiles, AED, BLS	68
9310-0994-04	Keypad Tiles, Pacer, BLS	70
9500-0747	Cable, Assembly, Pace Encoder	59
9500-0748	Cable, Assembly, Main Switch	58
9500-0772	Cable Assembly, Main Switch, Non-Pacing	73
9305-0928-01	Label, Pacer Overlay, BLS	75
Printer and Battery Well		
0163-0416	Scr. #6-32, MCH, 7/16", PNH, PHL, STL, Ext.	36

Part Number	Description	Item number
1009-0903-01	Assembly, Battery Well Module	76
1009-001919-02	Assembly, Printer	77
0163-0102	Scr. #6-32, MCH, 5/16", PNH, PHL, SST, Int.	78
Labels (English)		
9305-0789-01	Label, Battery Well, Rear	79
9305-001797-01	Label, Panel Connector Rear, No Options	80
9305-0799-01	Label, Panel Connector Rear, w/SPO_2	80
9305-0929-01	Label, Panel Connector Rear, w/SPO_2/$EtCO_2$	80
9305-002094-01	Label, Panel Connector Rear, w/NIBP/SPO_2/$EtCO_2$	80
9305-0942-01	Label, Panel Connector Rear, w/$EtCO_2$/NIBP	80
9305-000998-01	Label, Panel Connector Rear, w/$EtCO_2$	80
9305-0792-01	Label, Test Port	81
9310-0888	Guard, SpO_2	82
9330-0761	Adhesive Guard, SpO_2	83
9305-0798	Label, logo, Masimo	84
Front Panel Keypads (English)		
9310-0792-01	Keypad, Front Panel, Manual 1, w/Pacer, Analyze, no NIBP	57
9310-0804-01	Keypad, Front Panel, Basic 1, w/Pacer, No Analyze, no NIBP	57
9310-0805-01	Keypad, Front Panel, Basic 2, No Pacer, No Analyze, no NIBP	57
9310-0886-01	Keypad, Front Panel, Manual 2, No Pacer, w/Analyze, no NIBP	57
9310-0970-01	Keypad, BLS	57
9310-0982-01	Keypad, Front Panel, Manual 1, ALS, w/NIBP	57
9310-0983-01	Keypad, Front Panel, ALS, Manual 2, w/NIBP, no Pacer	57
9310-0984-01	Keypad, Front Panel, ALS, Basic 1 w/NIBP, w/Pacer	57
9310-0985-01	Keypad, Front Panel, ALS, Basic 2, w/NIBP	57
9310-0986-01	Keypad, Front Panel, BLS/Plus w/NIBP	57
Front Panel Assembly		
9310-004782	OVERMOLD, PANEL, FRONT, R SERIES	108
9301-002532-01	ASSY, PCB, CONTROLS BOARD, R SERIES	109
0163-0402	SCR.PPH.#4.x 0.250".STL./ZNC.HI/LO RoHS	110
9310-0996	BUTTON SEAL, RBLS	111
0350-000080	TFT-LCD MODULE.640X480 PIXEL.6.5" DIAGONAL.	112

Part Number	Description	Item number
9500-000799	ASSY, CABLE, COLOR LCD, R SERIES	113
9355-000386	ASSY INVERTER 5VDC 1 A	114
9330-0772	MOUNT, ADHESIVE, COLOR INVERTER, PCB, R SERIES	115
0163-0427	CLIP.RIGID PVC.PSA BACKED.BLK.SUITABLE FOR 1/2" WIRE BUNDLE	116
9320-0762	DISPLAY, RETENTION PLATE, R SERIES	117
9161-0033	GASKET, FRONT PANEL TO PRINTER FLEX, R SERIES	118
9330-0766	DISPLAY SUPPORT, .31 THICK, R SERIES	119
9330-0748	DISPLAY, SUPPORT, R SERIES	120
9500-000665	ASSY, CABLE, CONNECTOR, INVERTER, COLOR LCD	121
9230-0272	EDGE GROMMET, R SERIES	122
0163-1228	SCR.PHH/PNH.#6.0.250".ST.ZINC.HI/LO	123
9500-001777	CABLE, ASSY, FLAT, 51 CONDUCTOR	124

Diagrams

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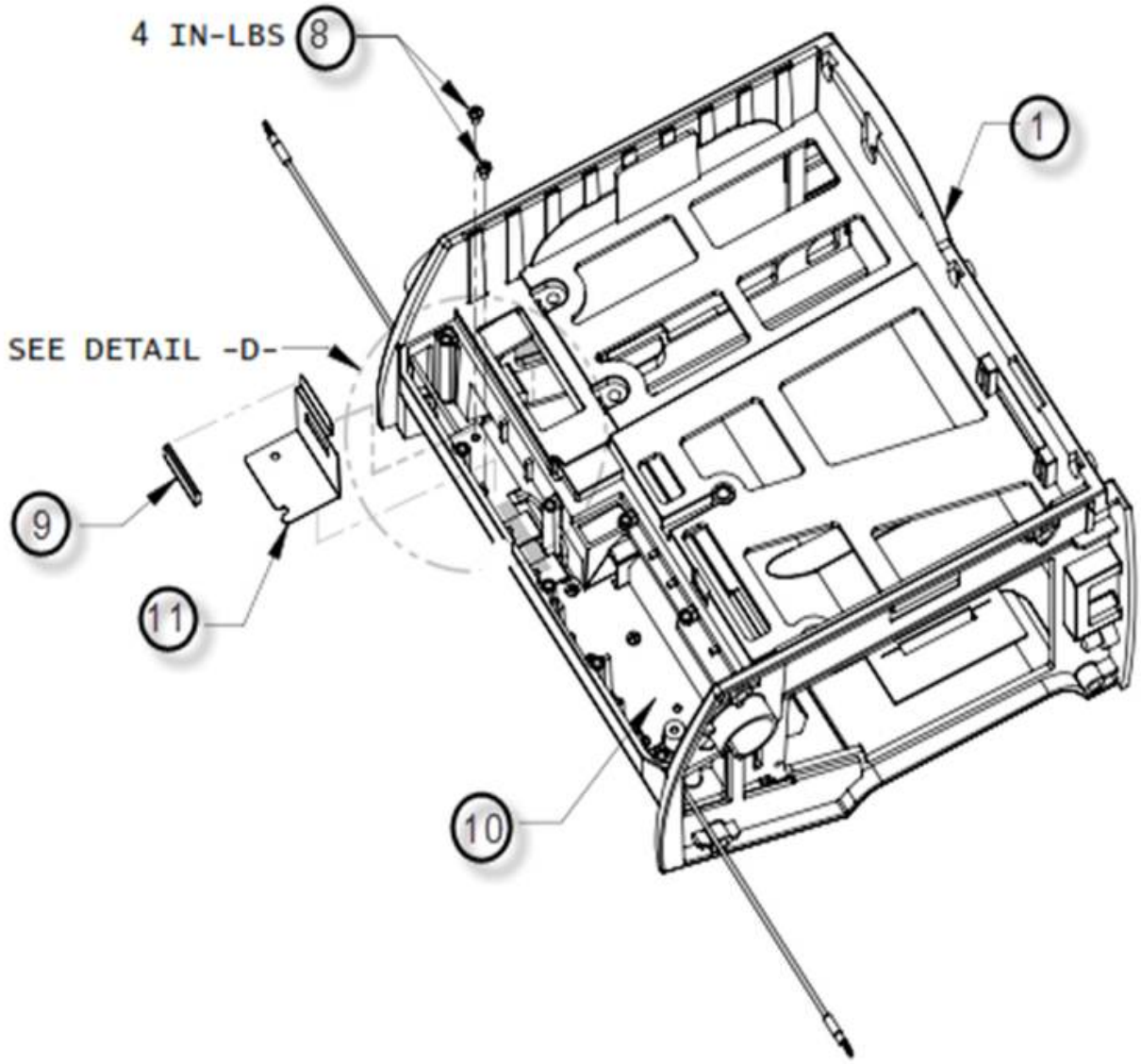
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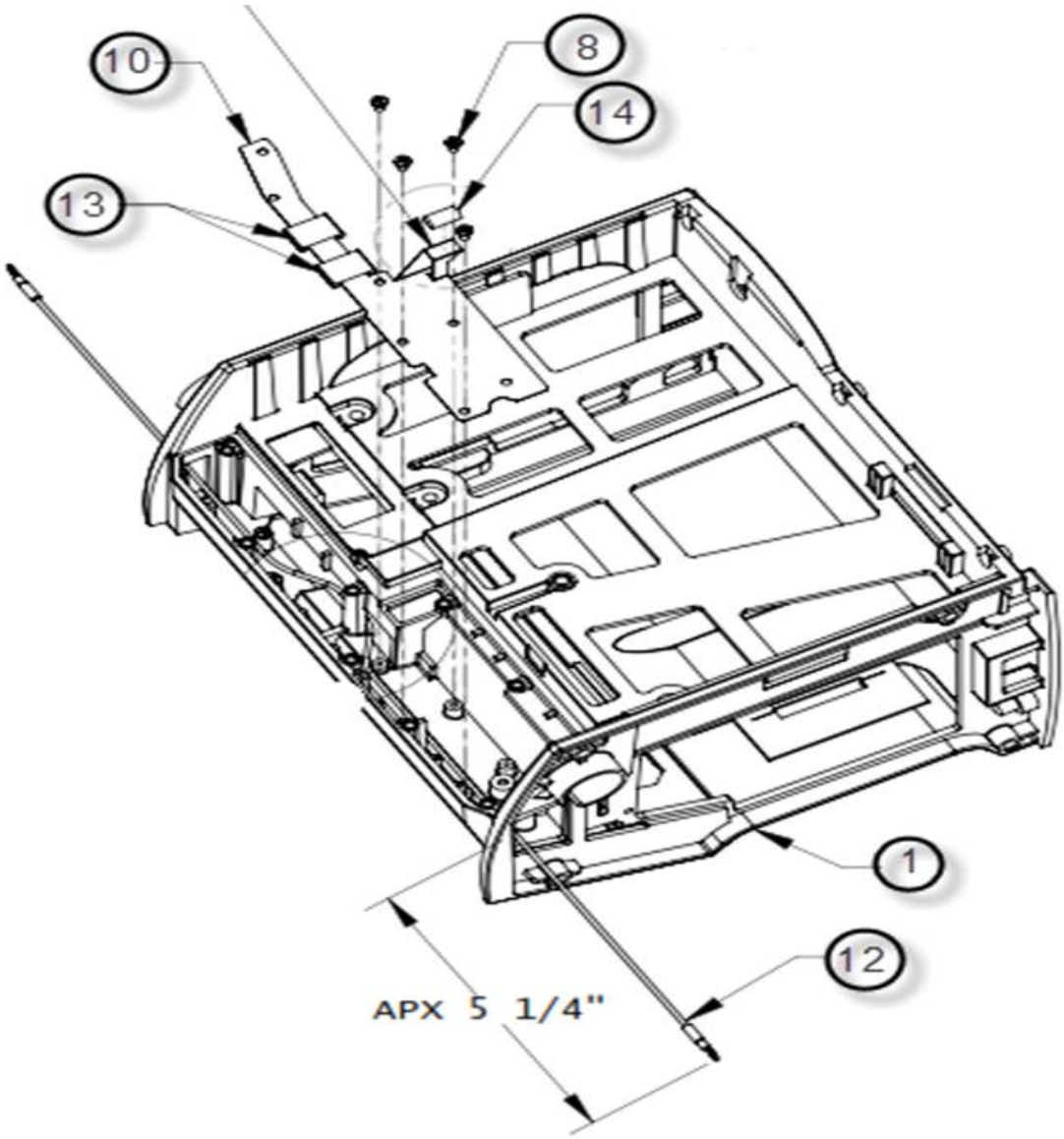
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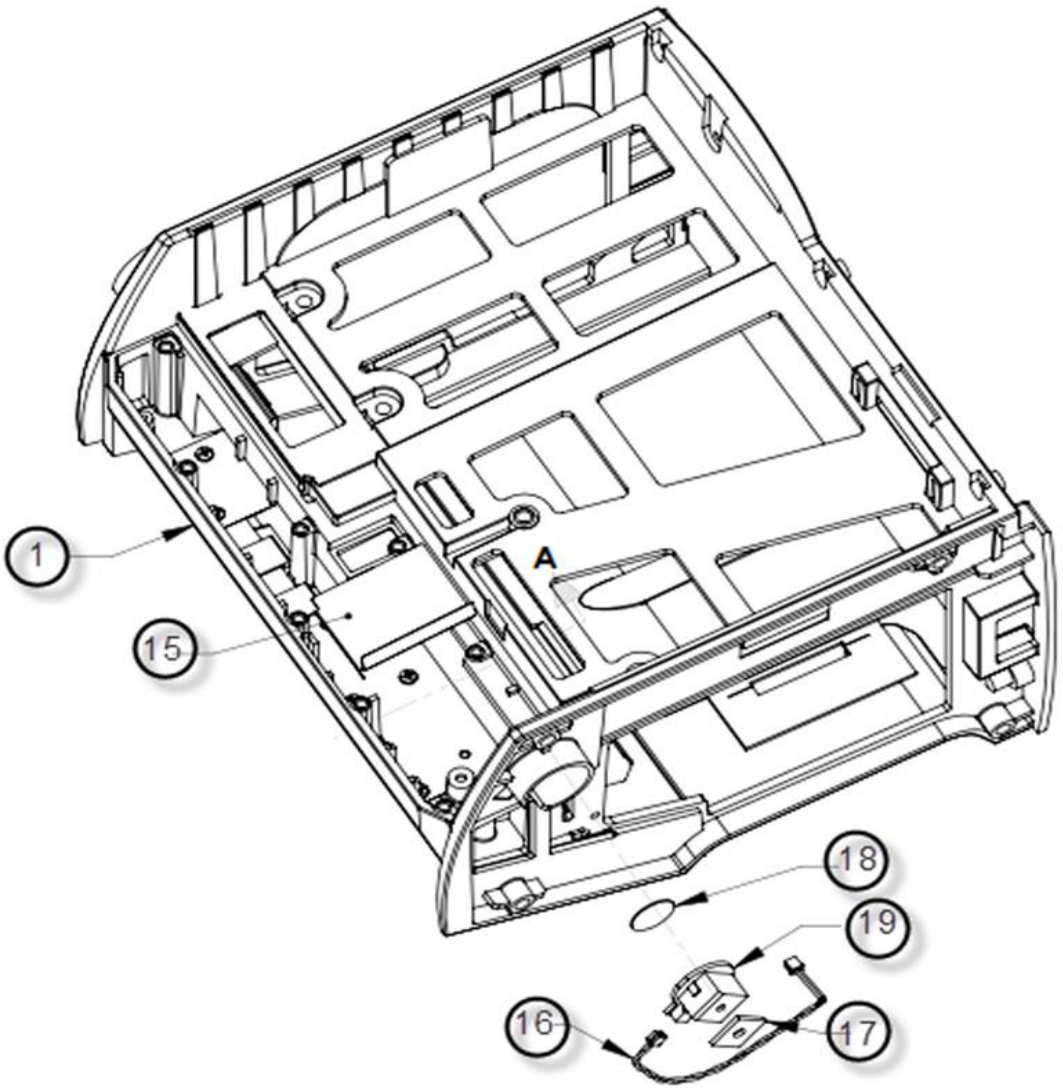
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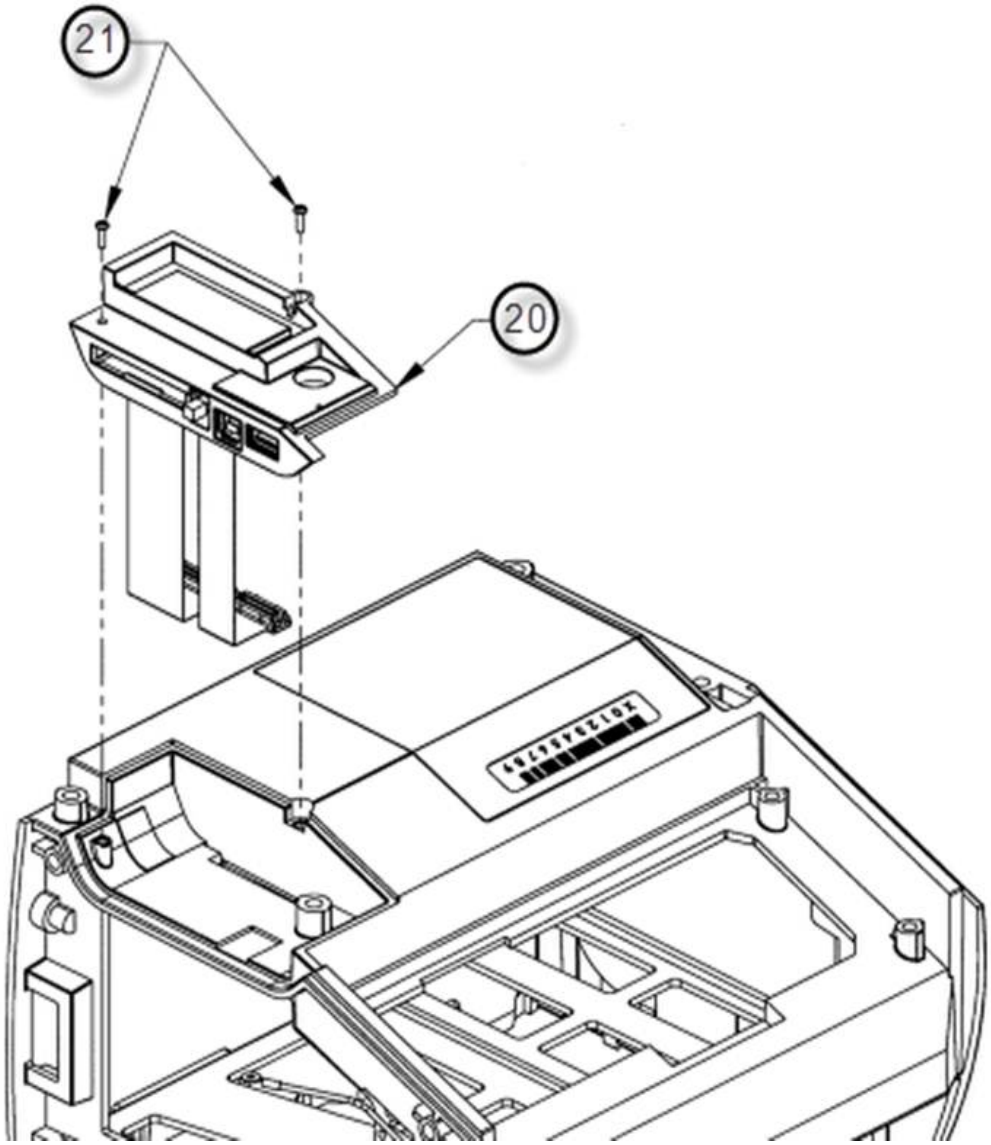
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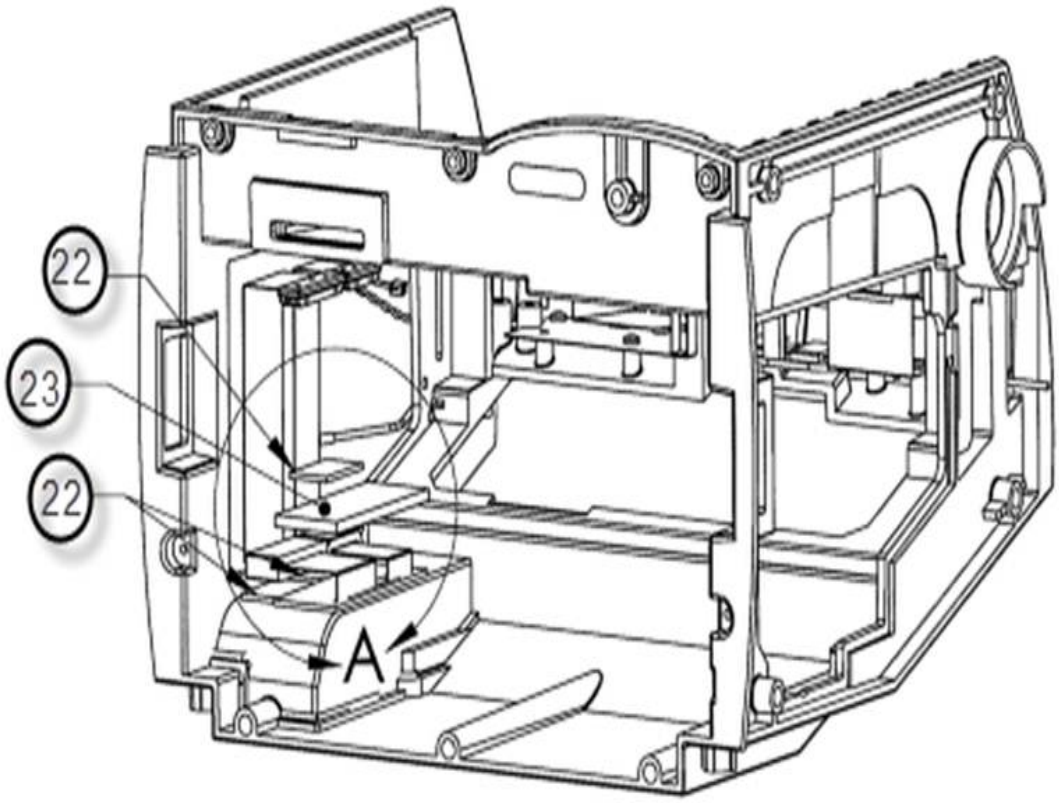
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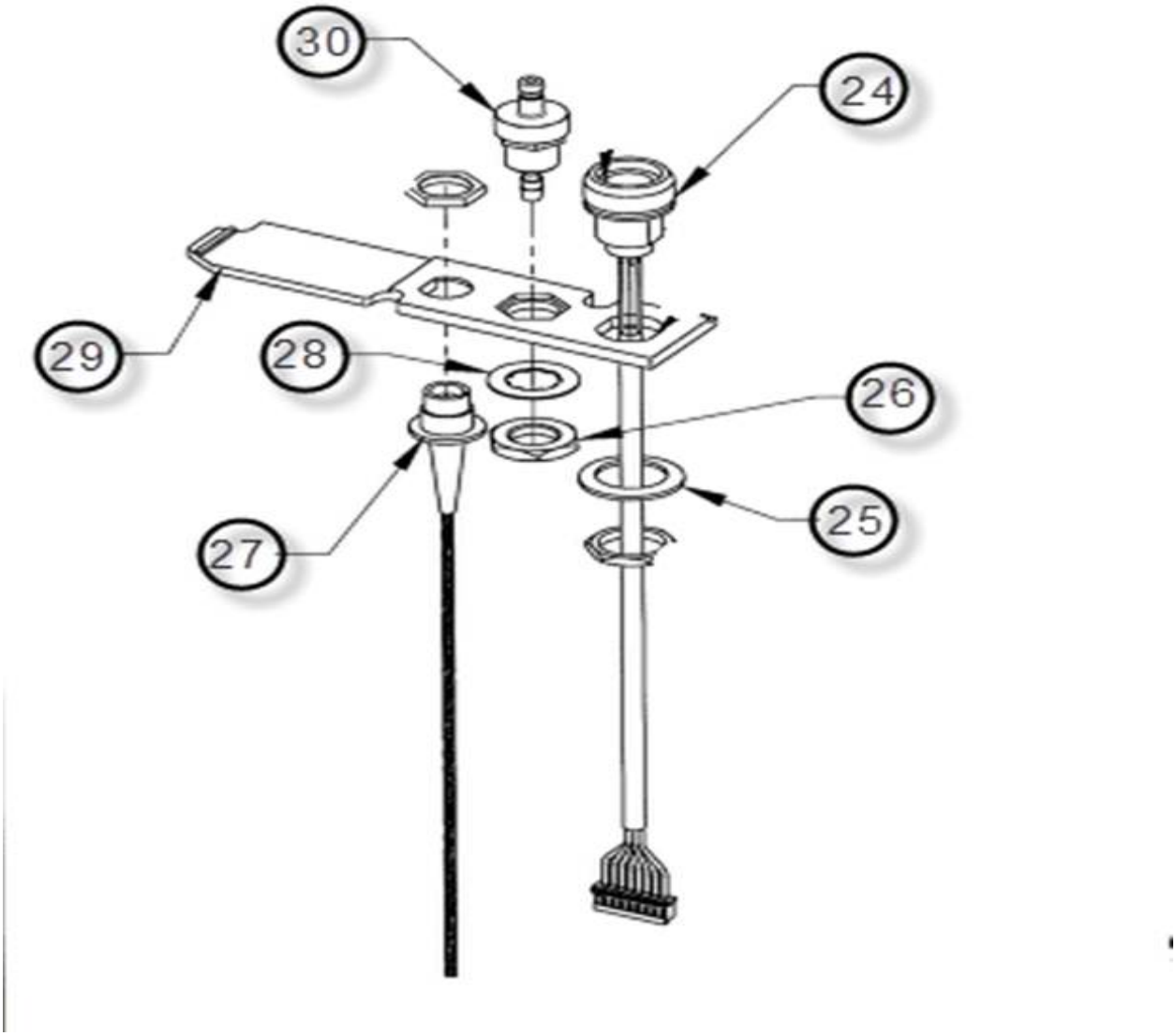
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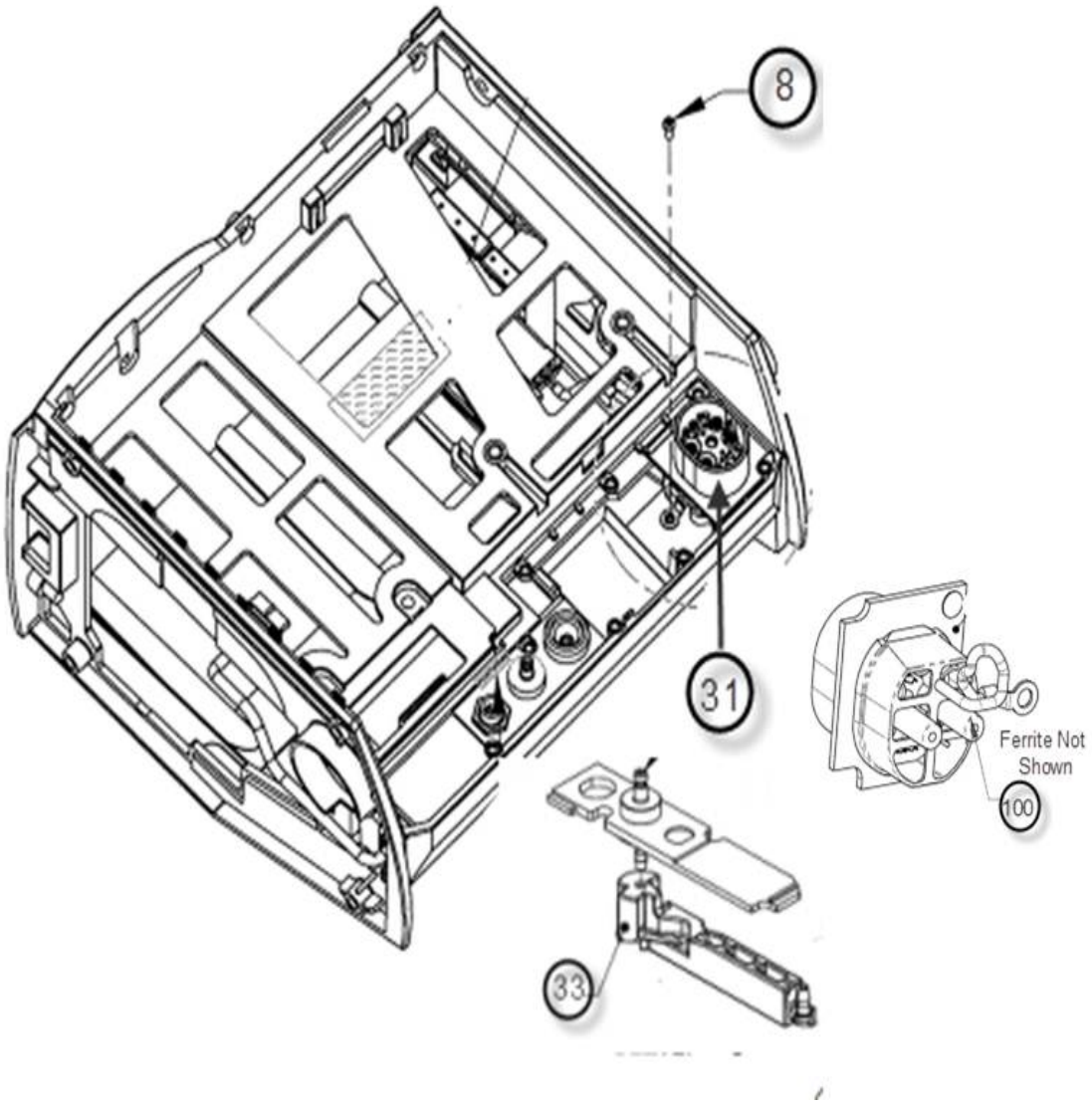
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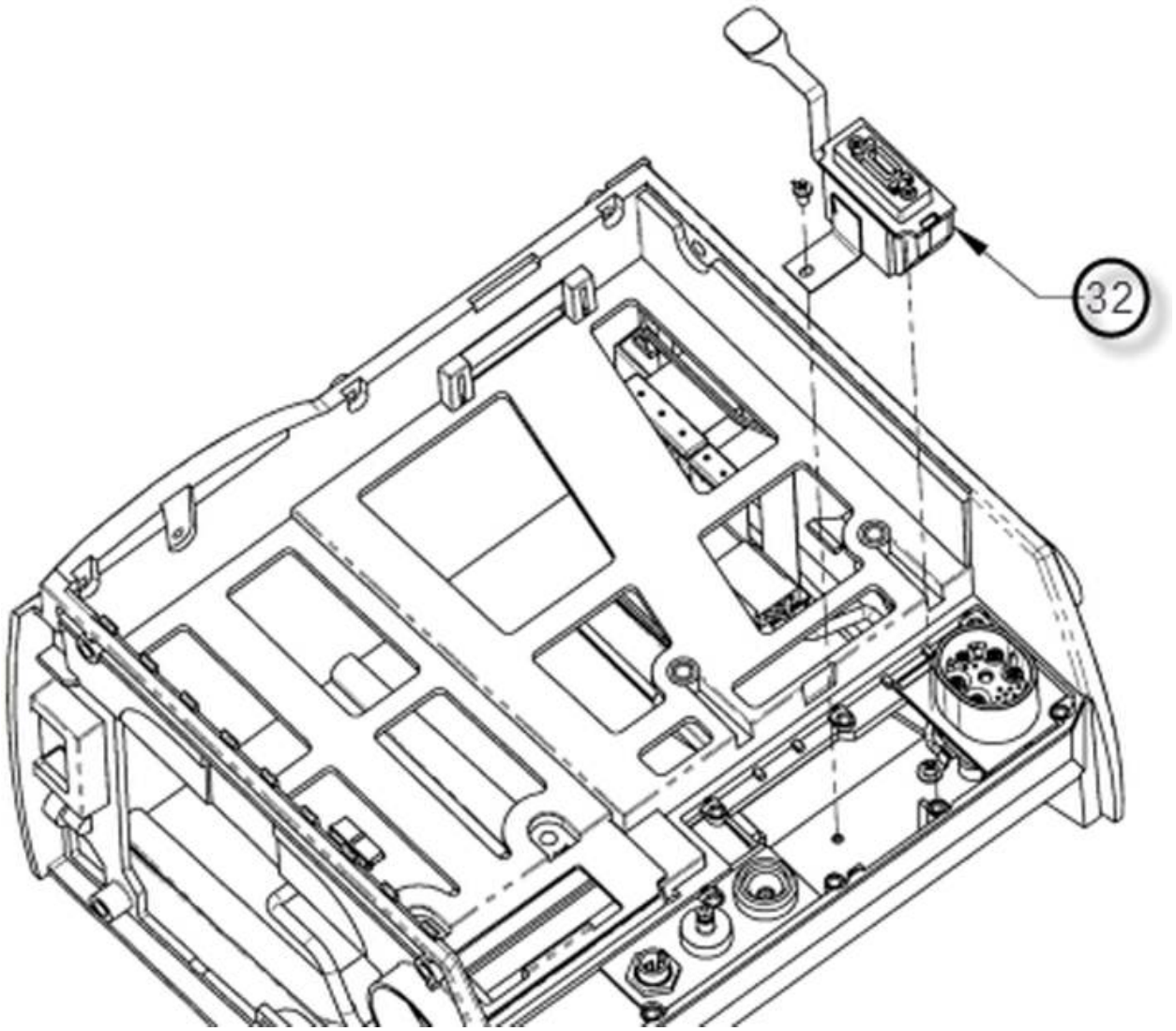
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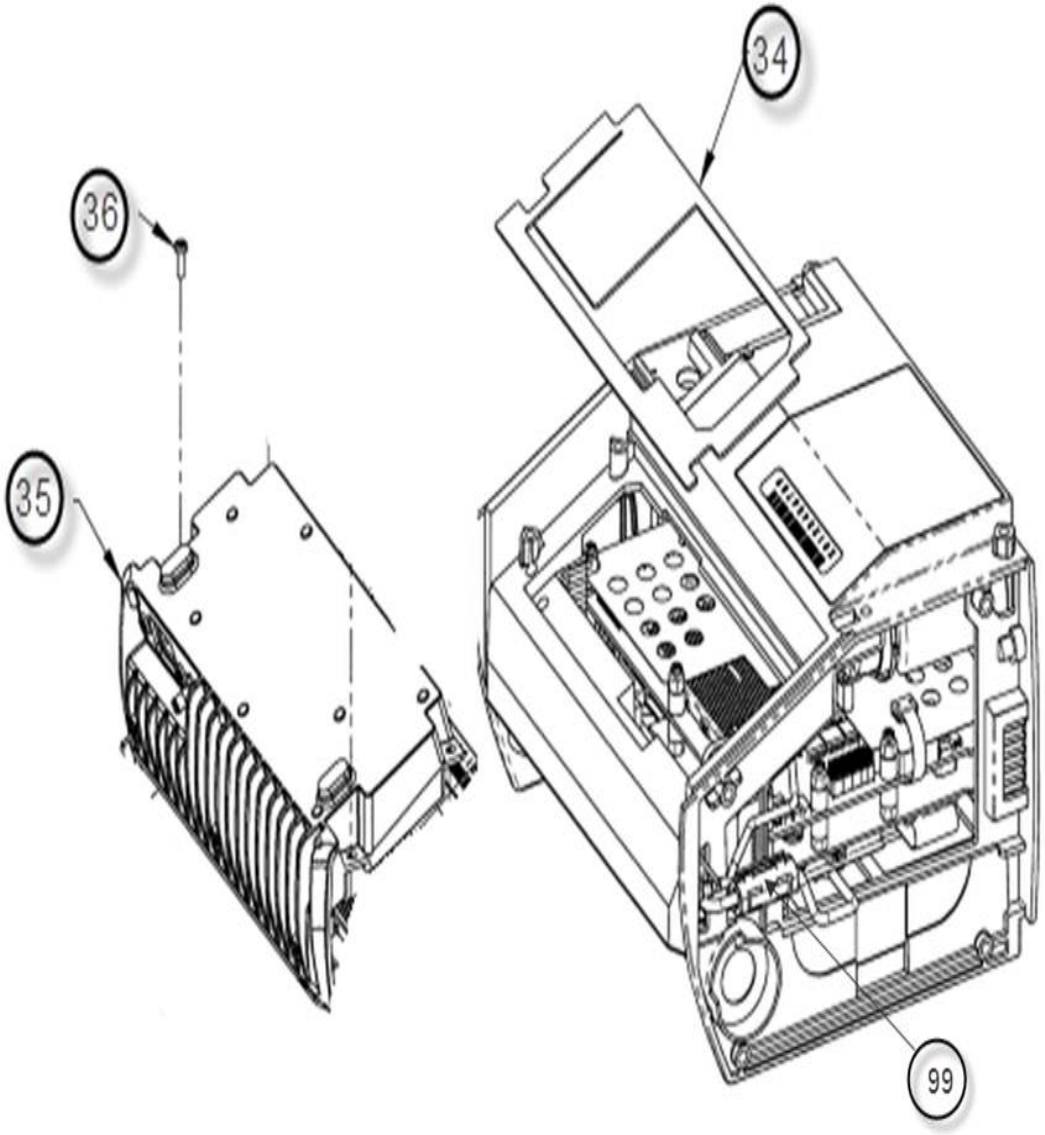
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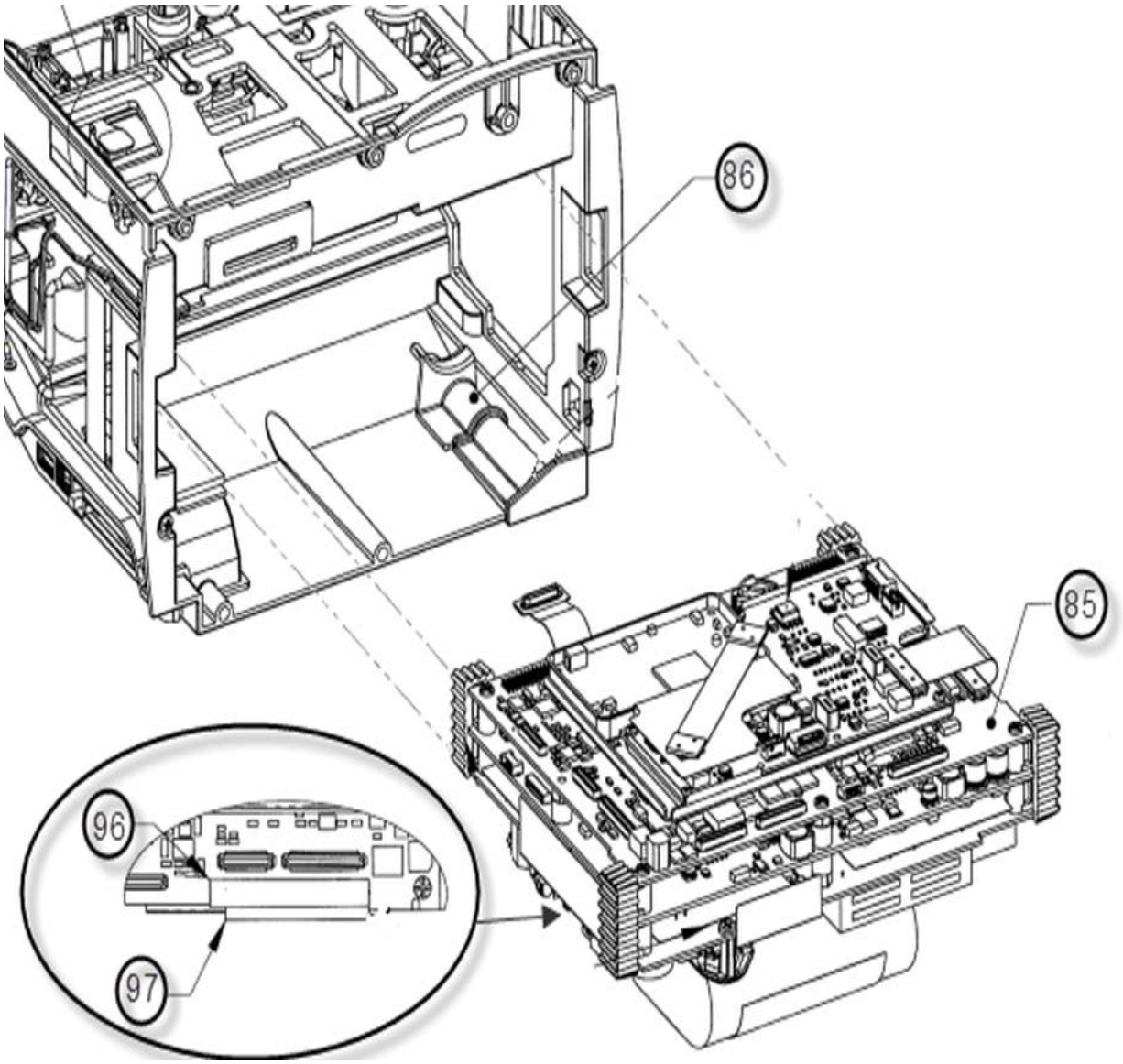
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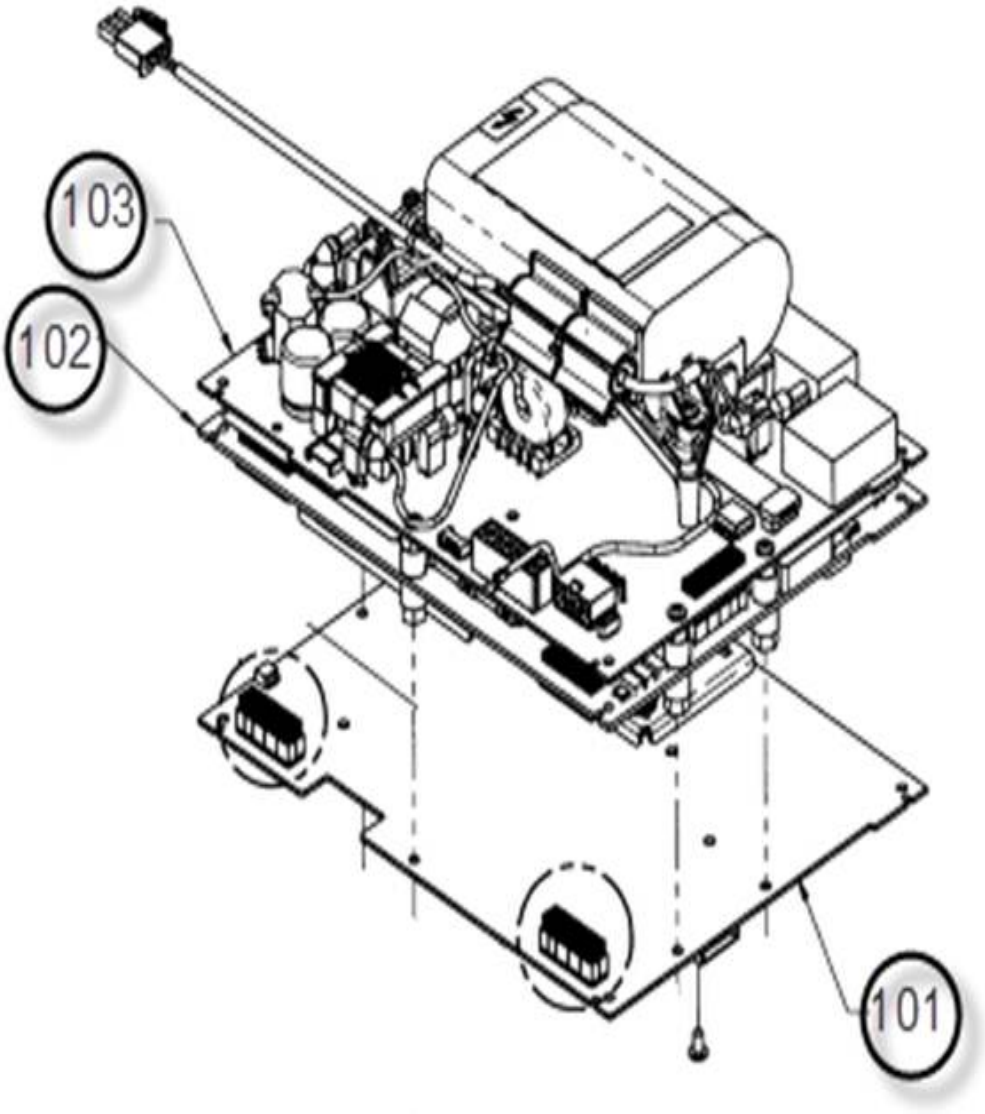
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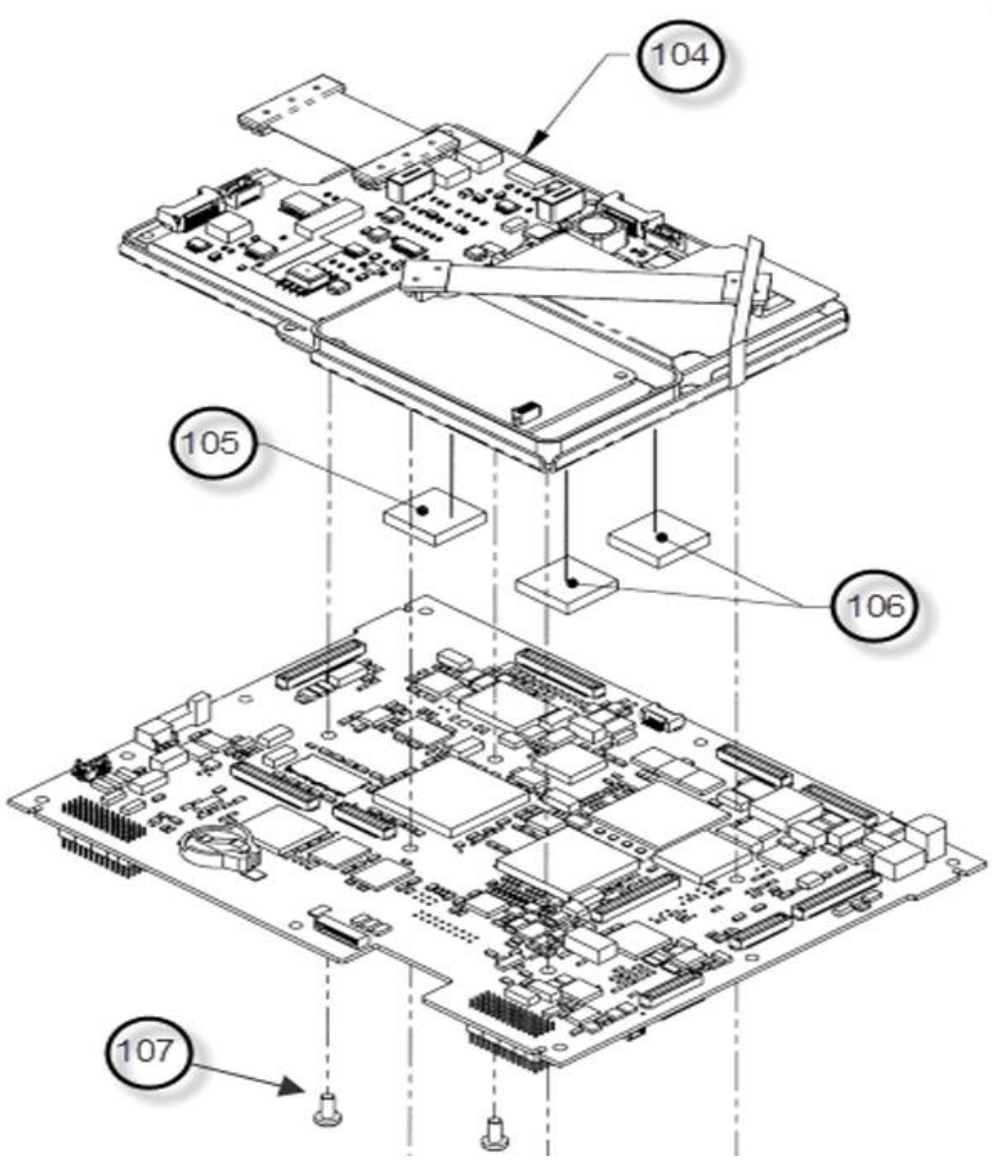
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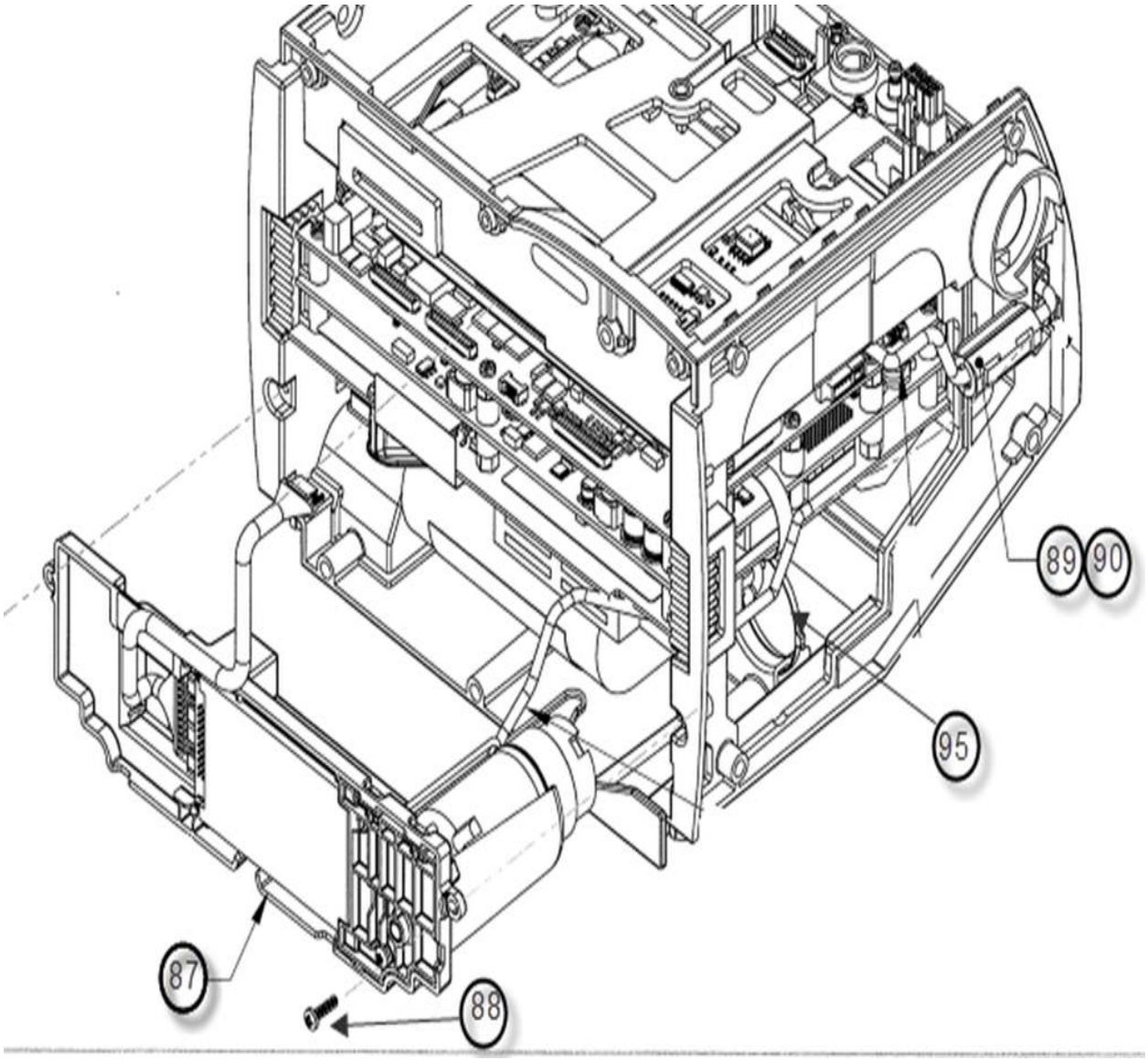
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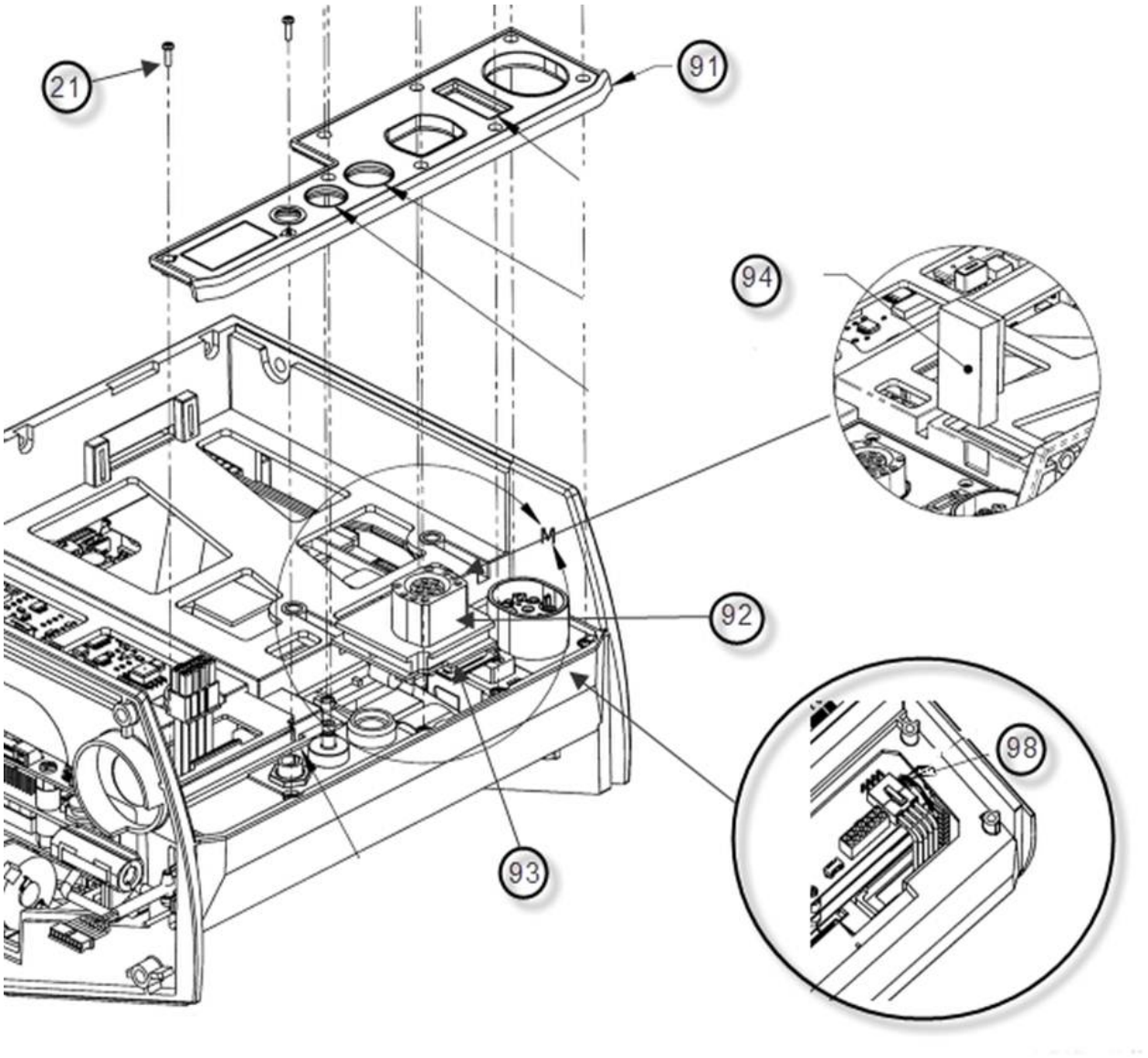
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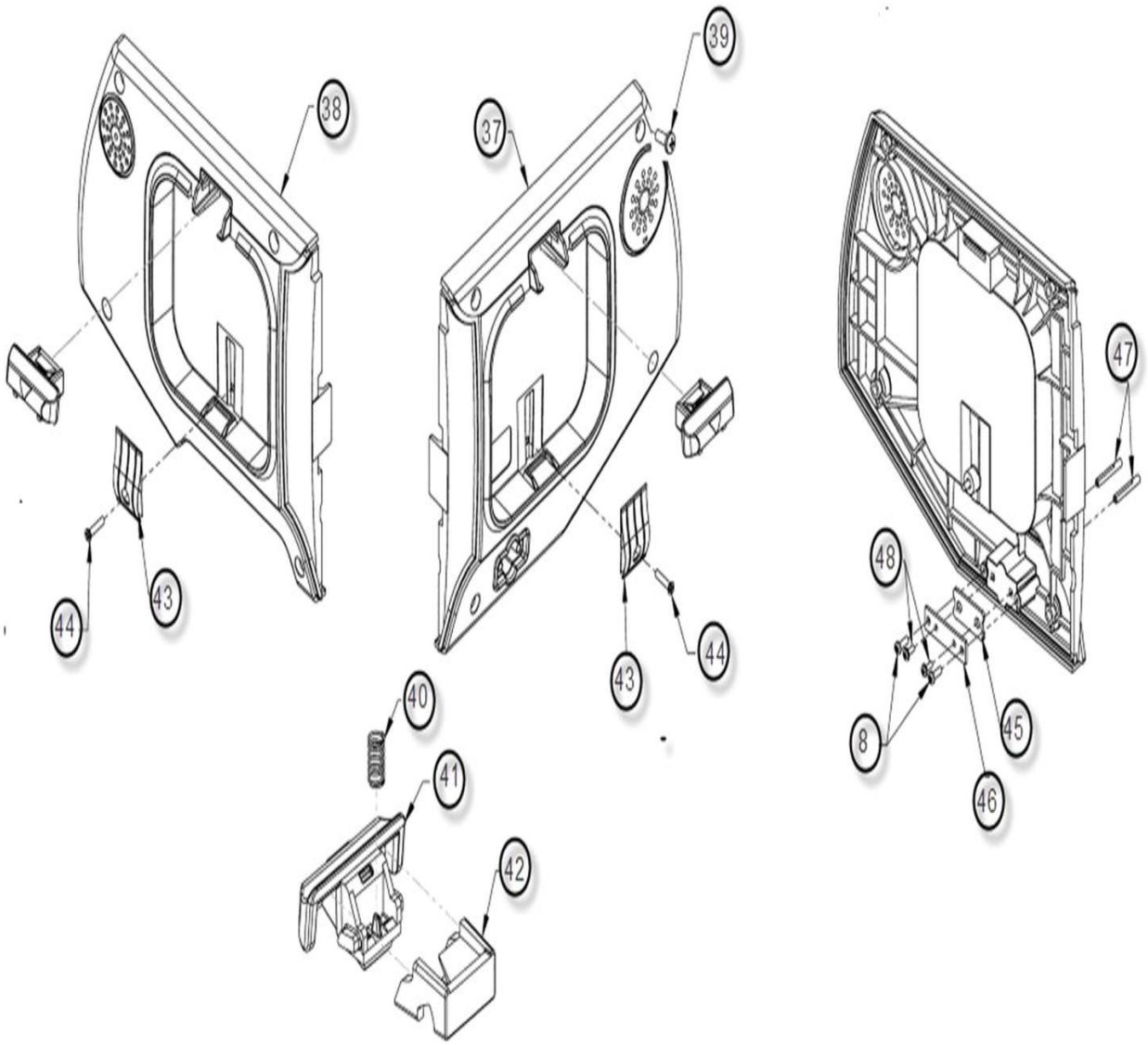
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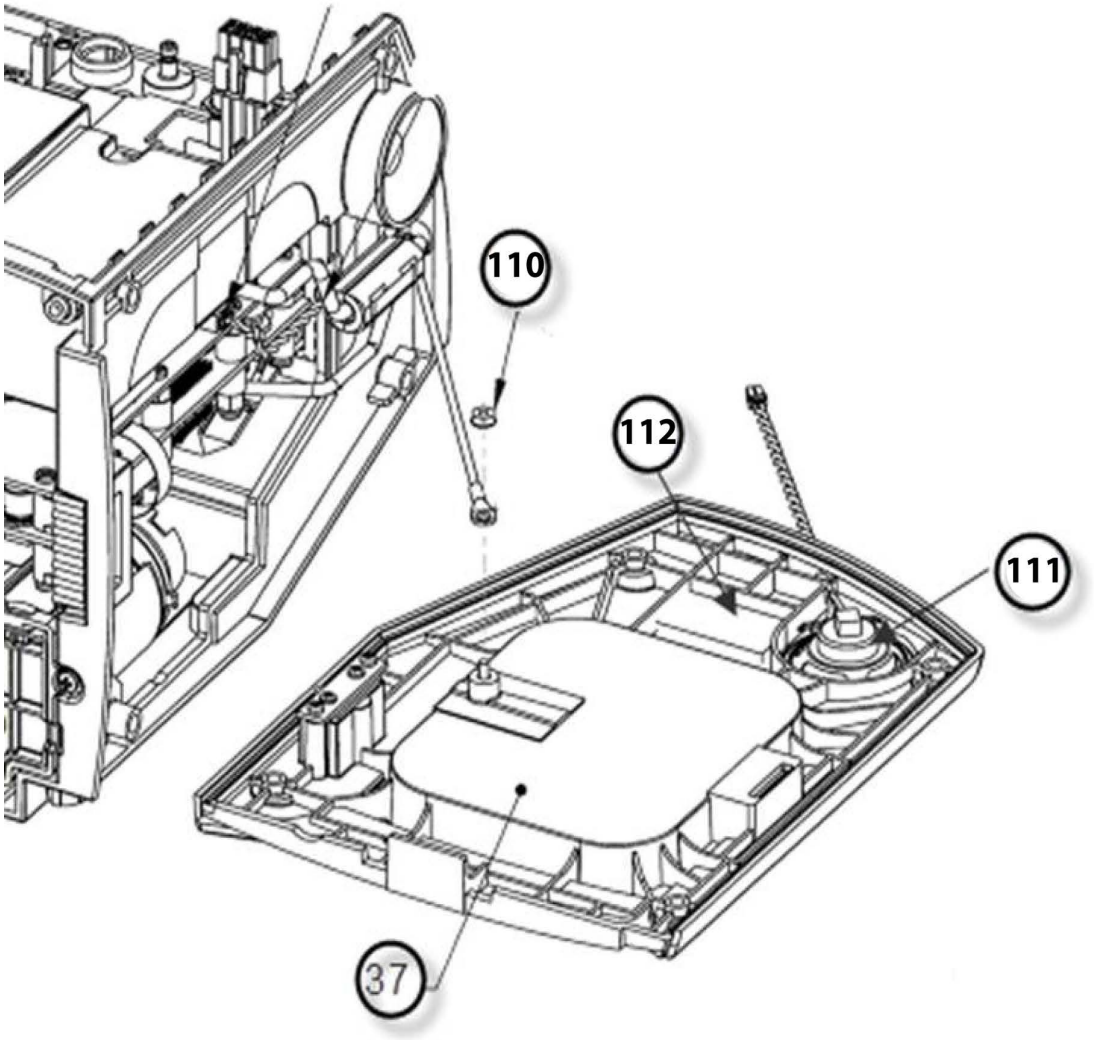
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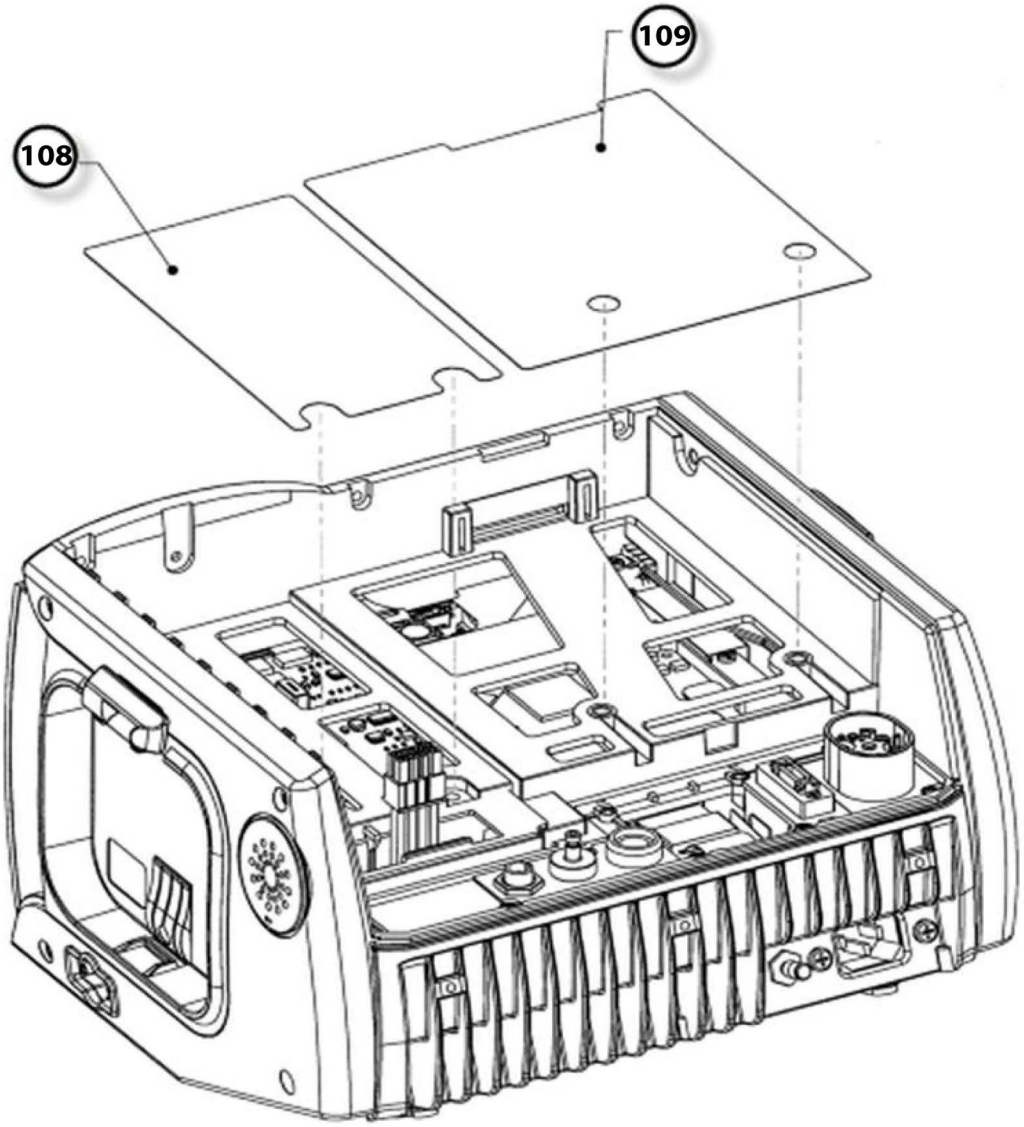
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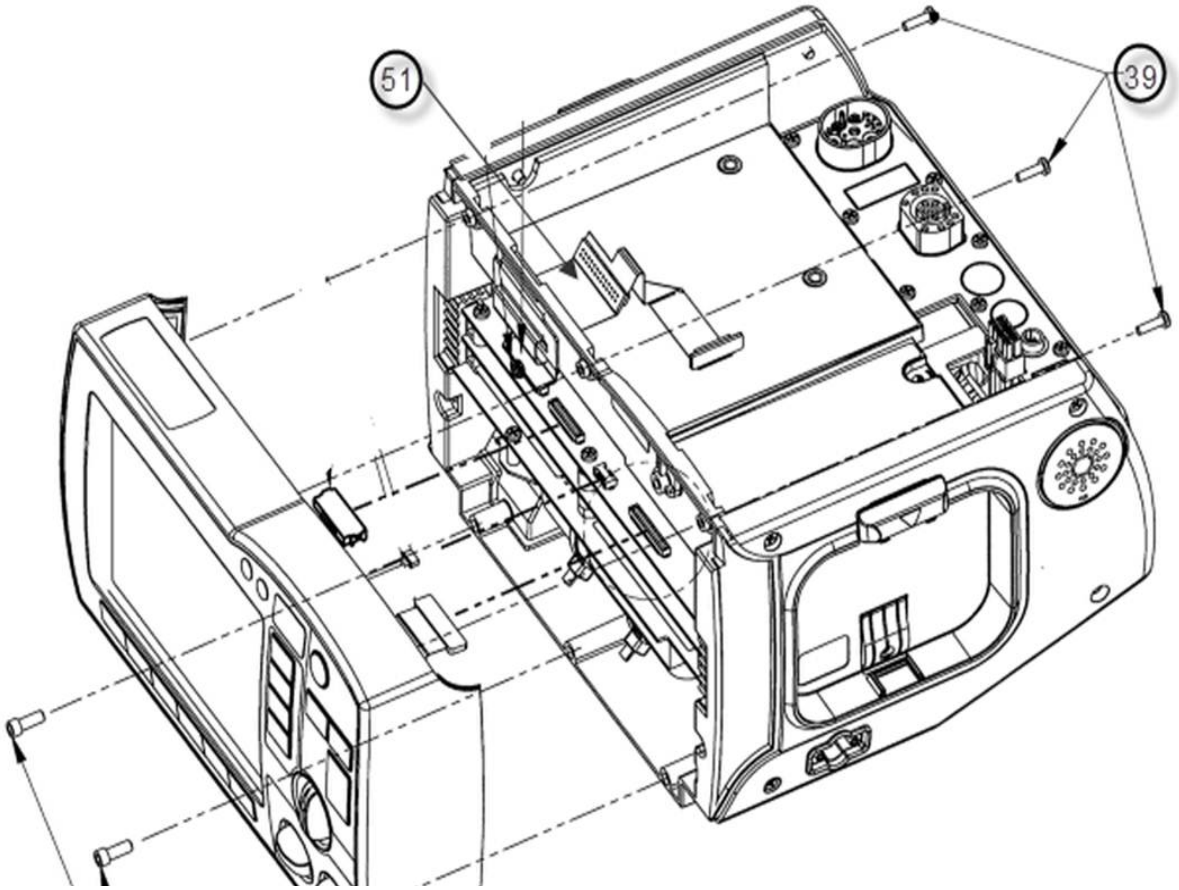
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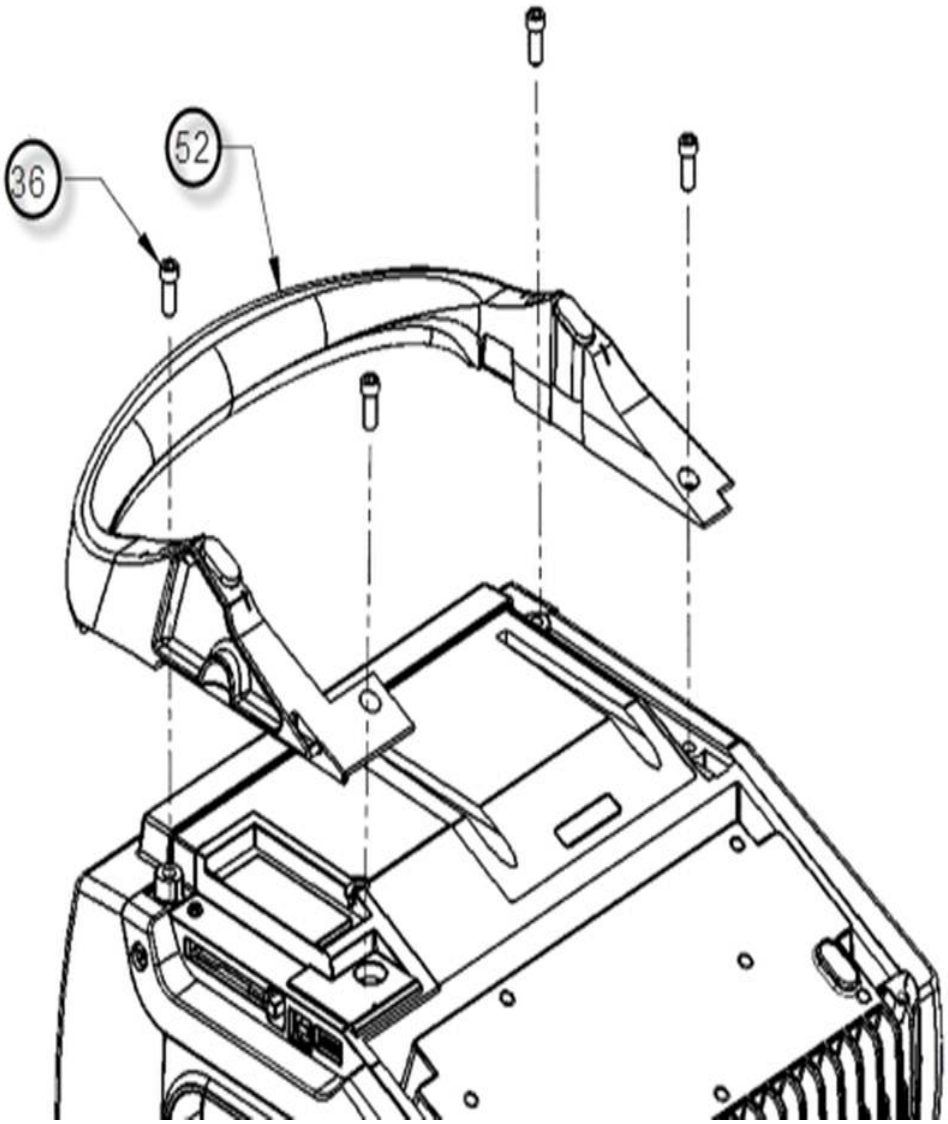
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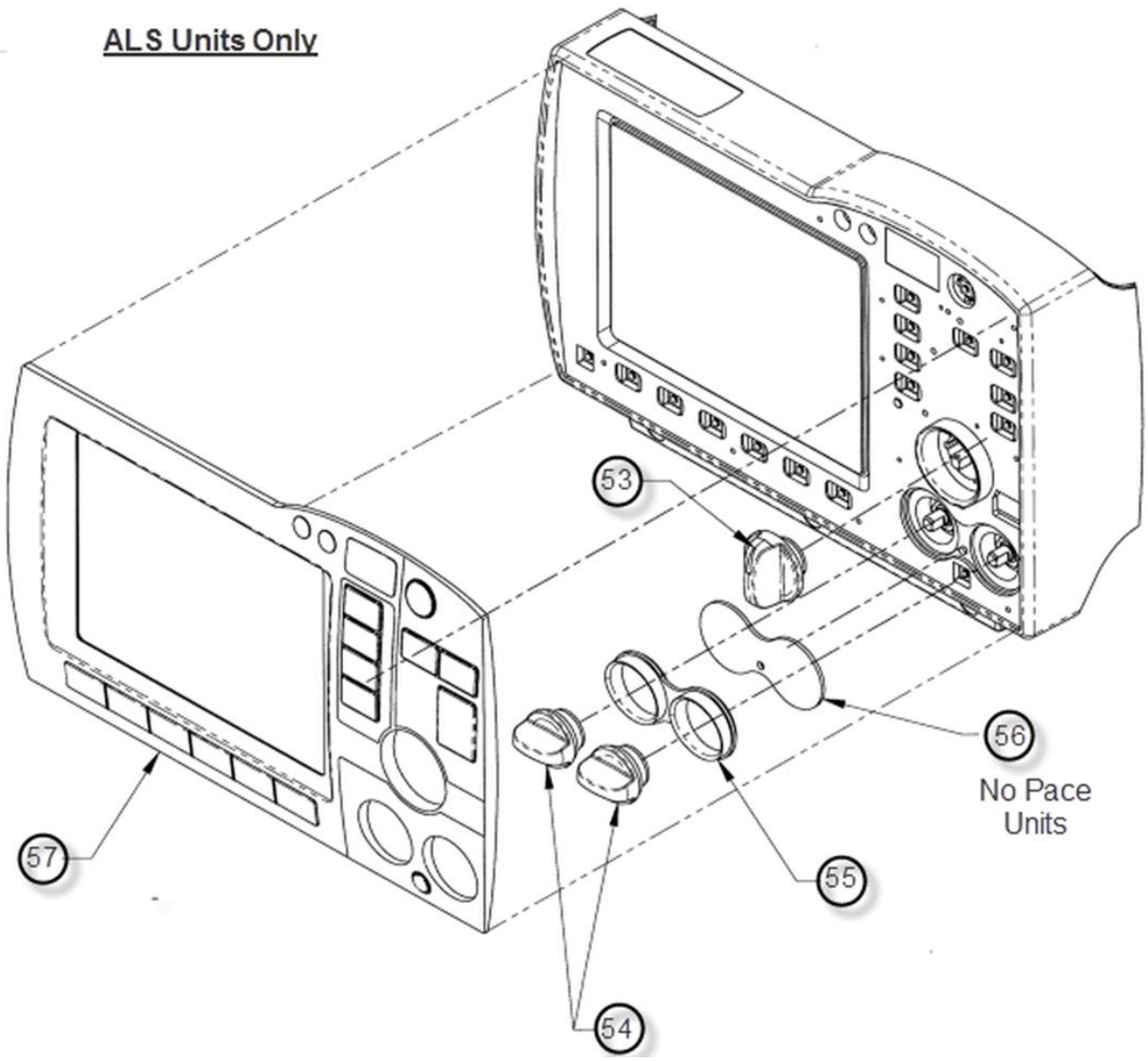
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No Pace
Units
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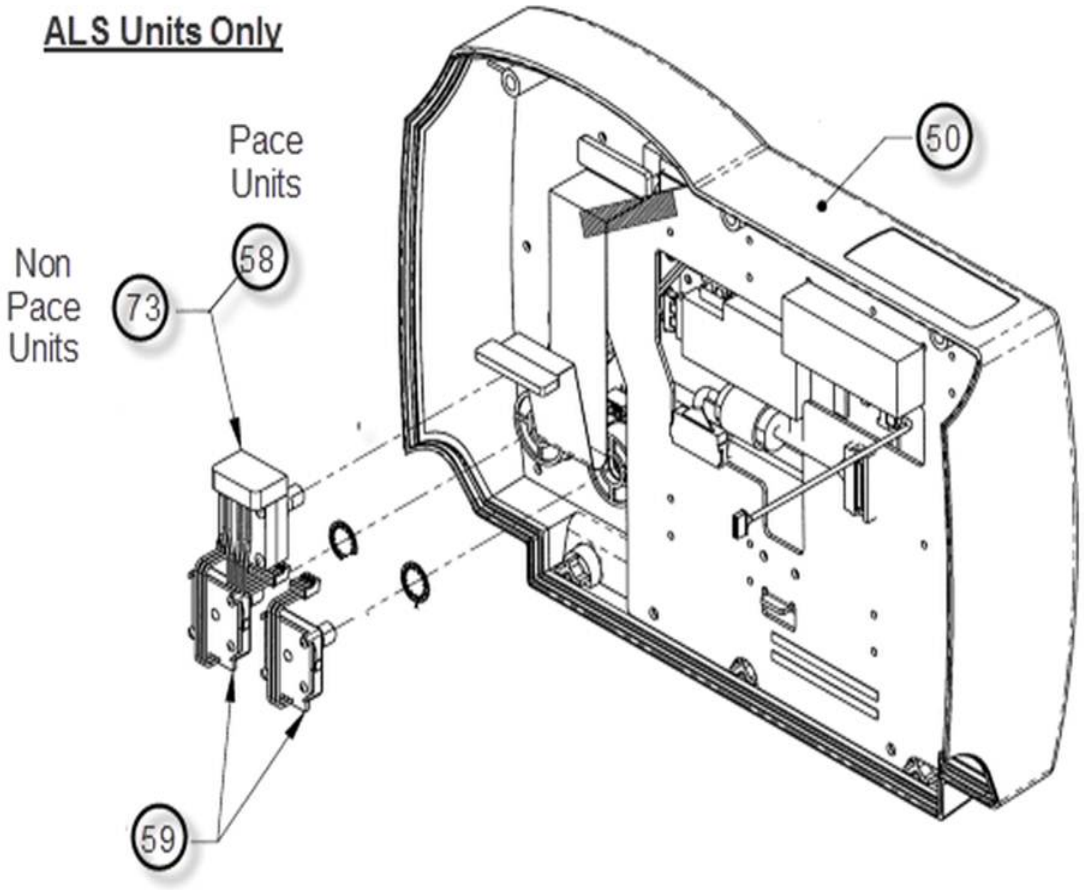
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Pace Units
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Non Pace Units
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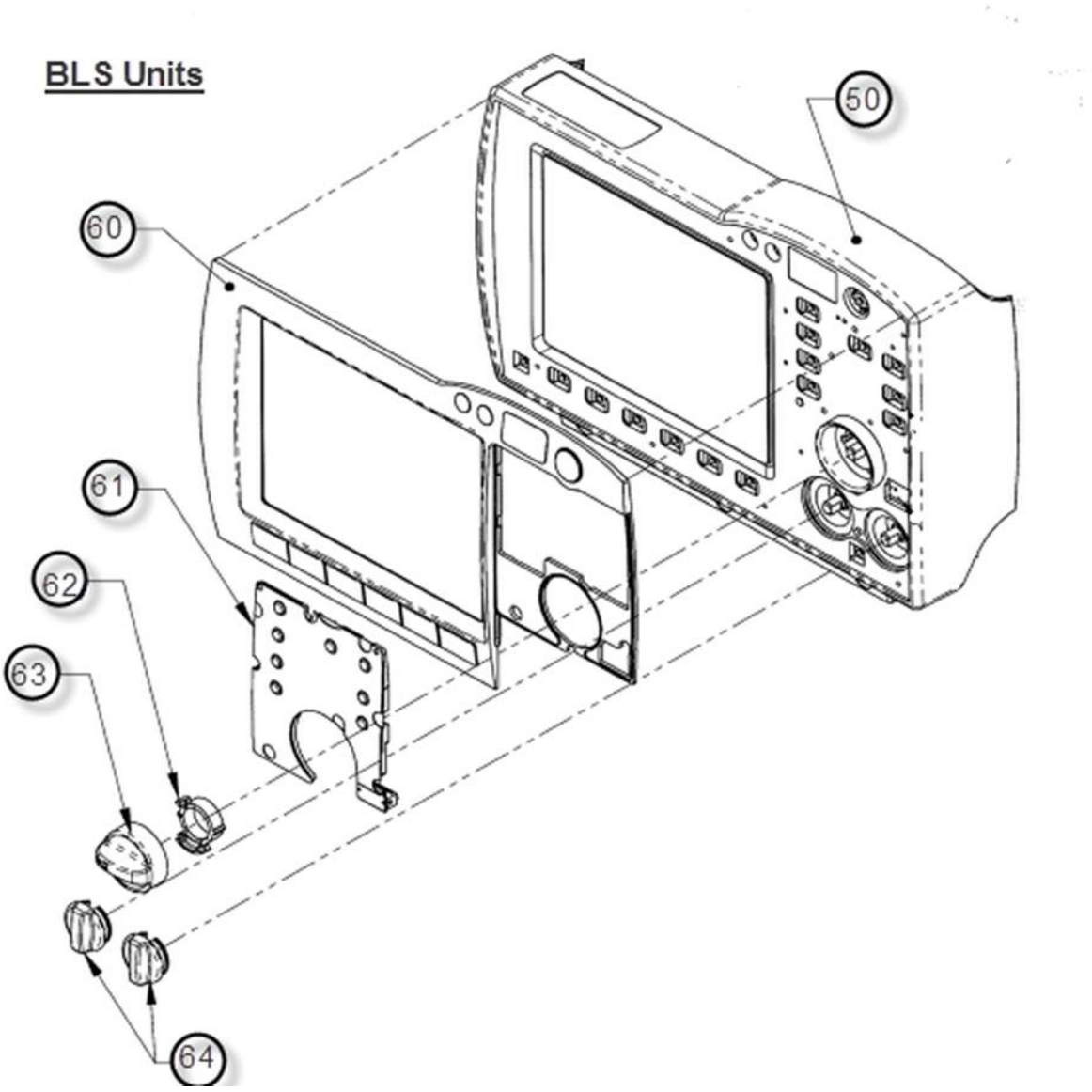
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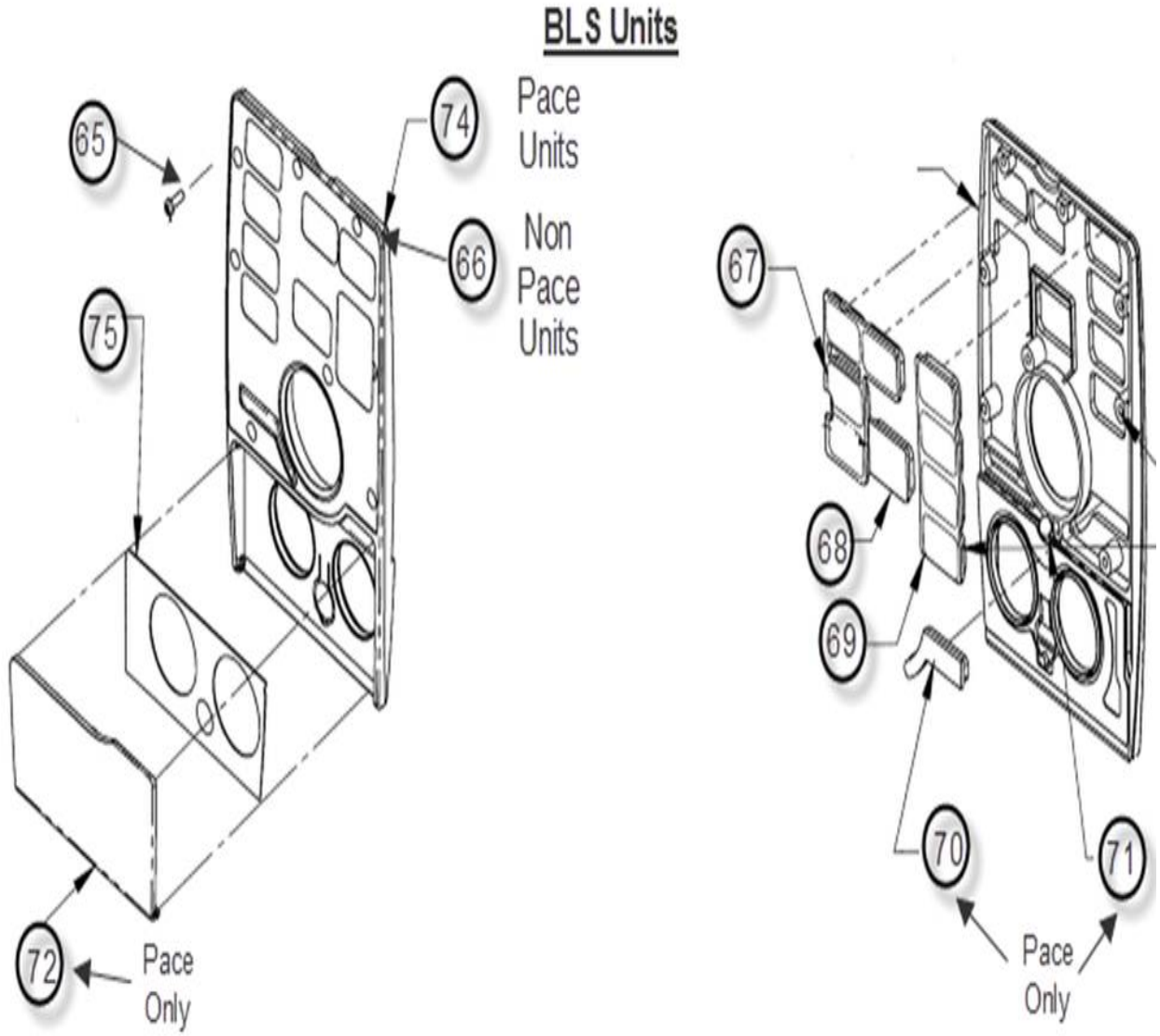
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Pace
Units
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Non
Pace
Units
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71
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Pace
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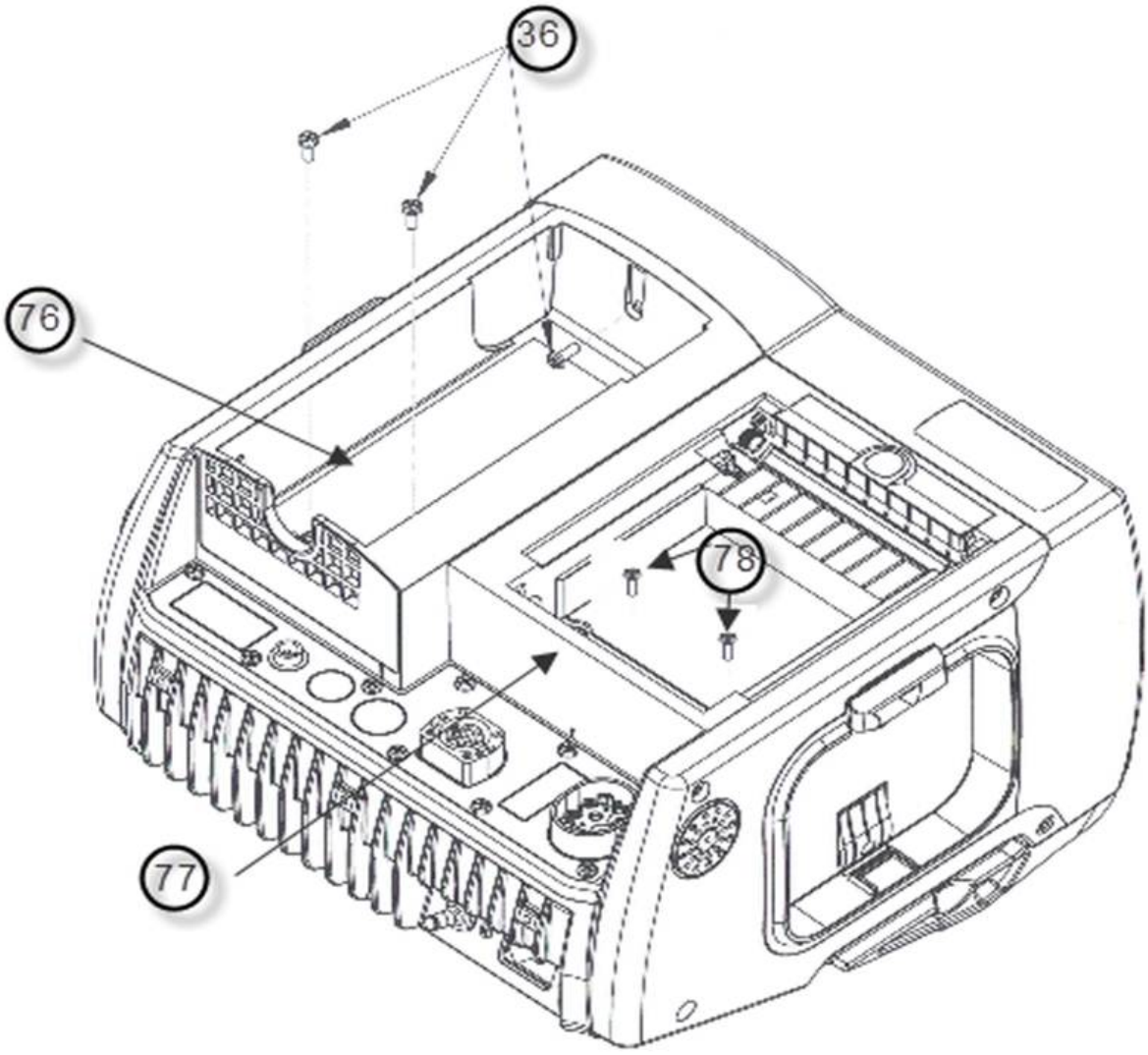
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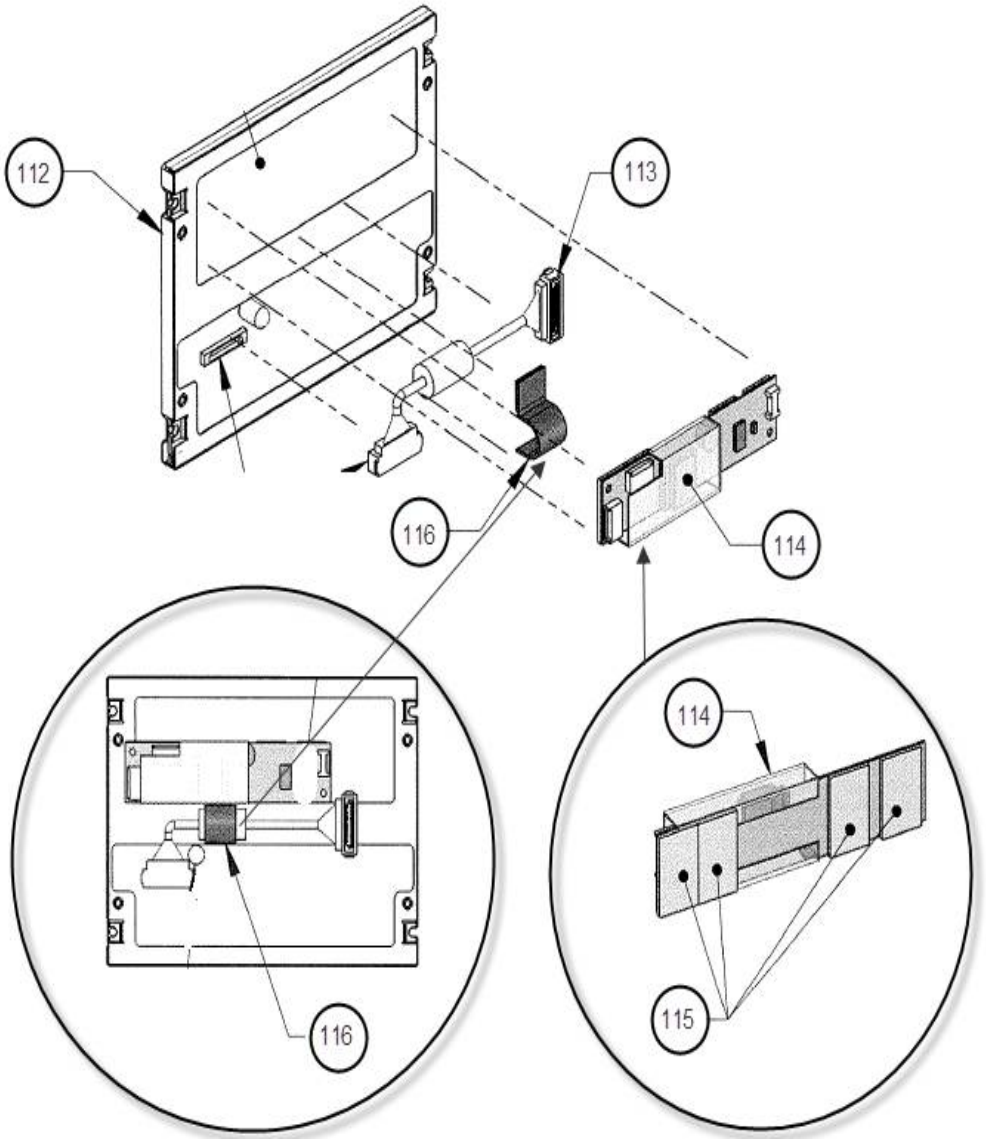
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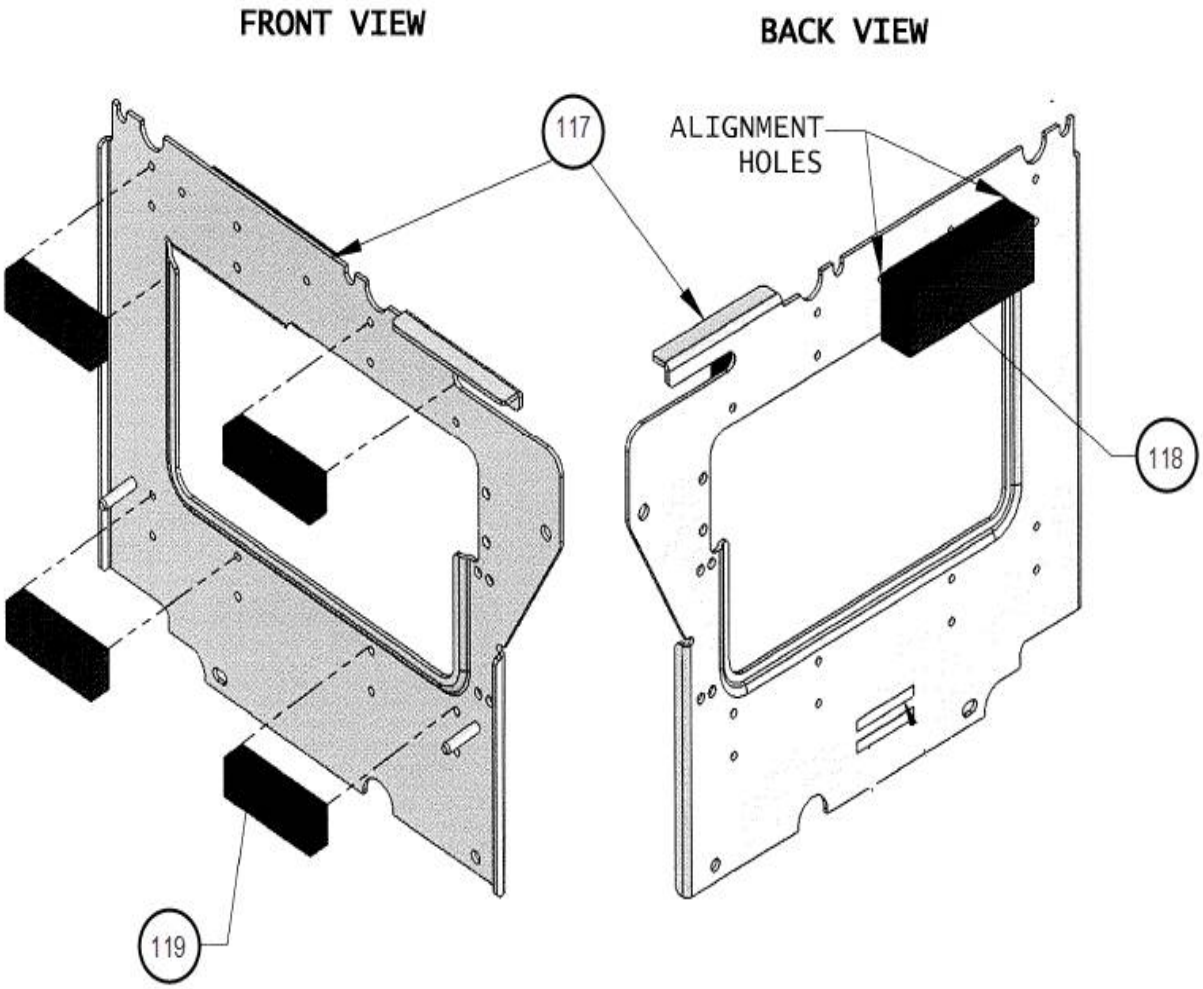
FRONT VIEW
BACK VIEW
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ALIGNMENT
HOLES
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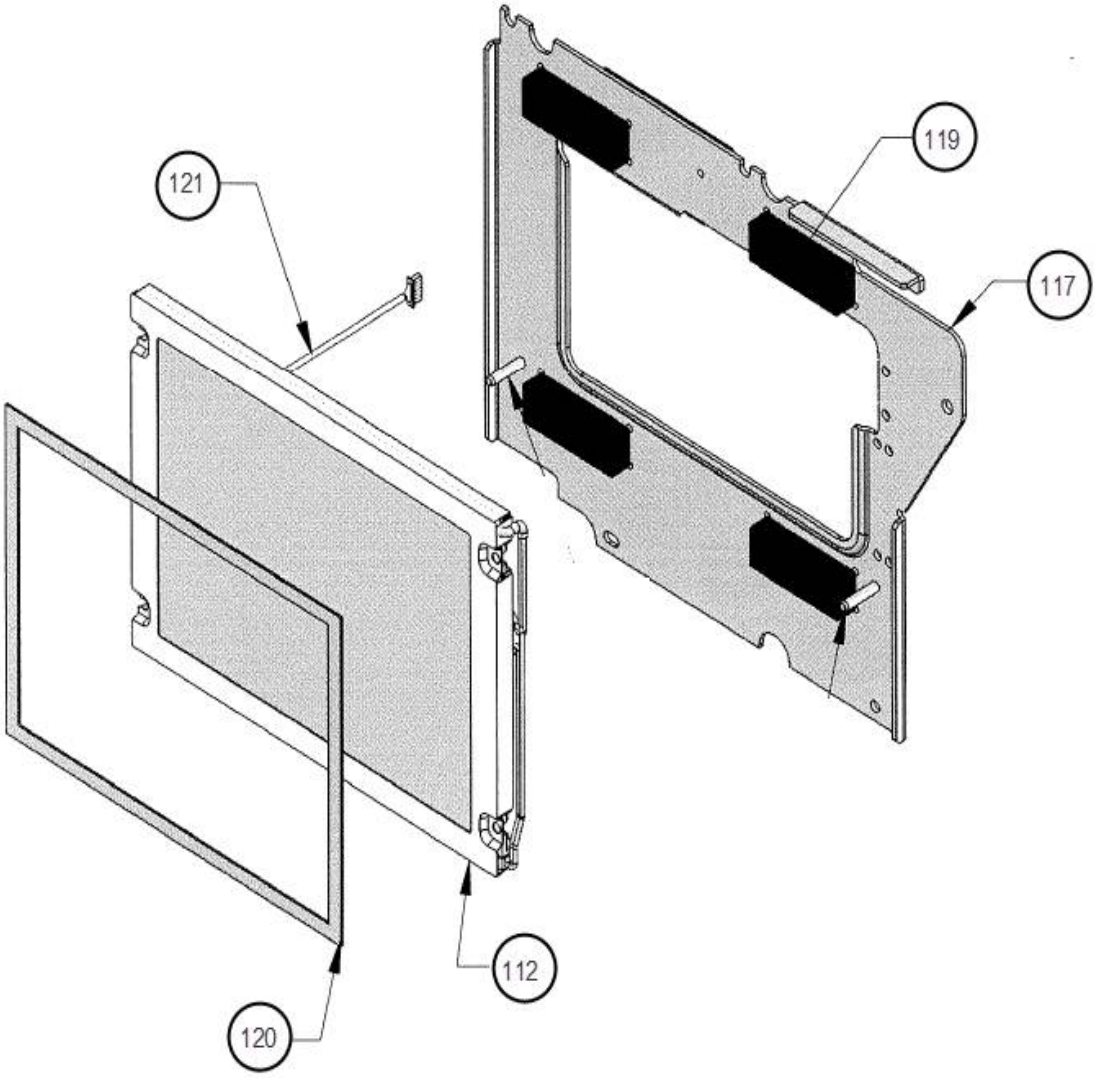
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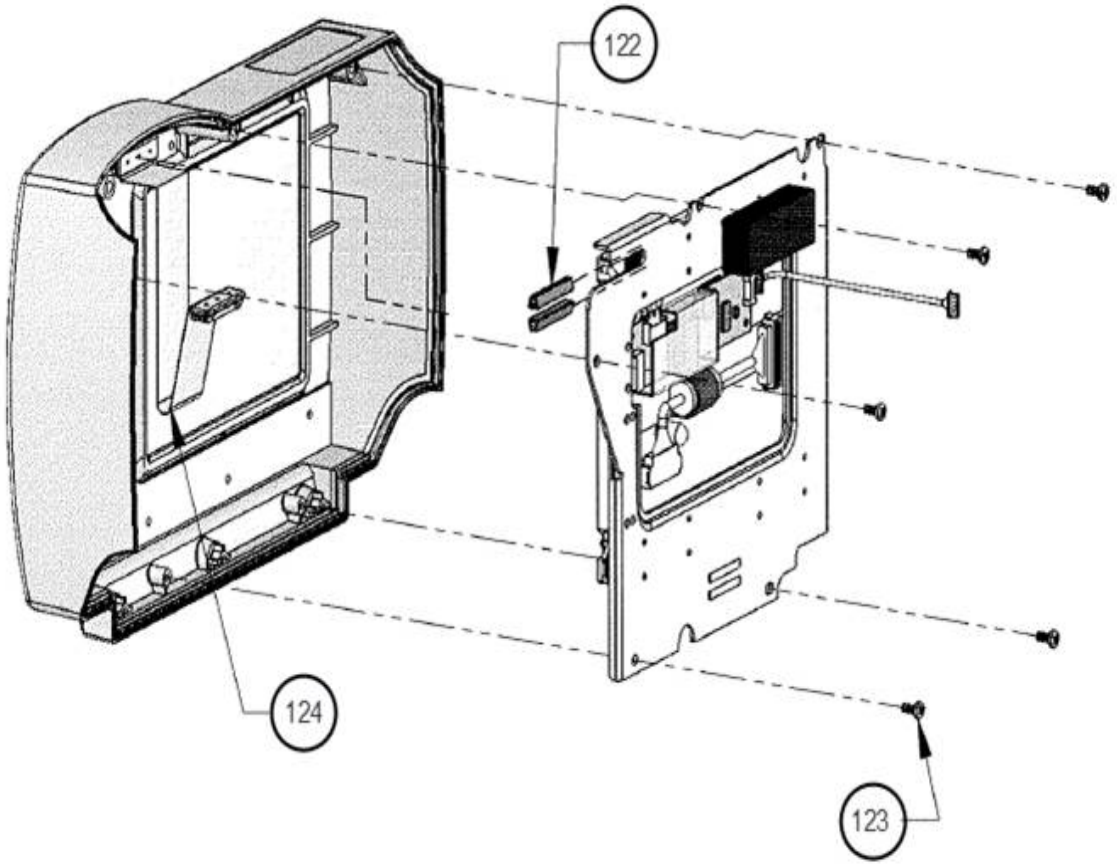
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Chapter 5
Functional Description

Overview

The R Series system is partitioned as shown in the R Series Interconnect Diagram (see Appendix A). Defibrillation, pacing, ECG monitoring, SpO_2 monitoring, $EtCO_2$ monitoring, NIBP monitoring, and printing and communication are all combined in the device. Power is provided by AC mains or by a replaceable battery pack that is rechargeable in the device.

AC Charger

The AC charger converts AC power to DC for battery charging and R Series operation. The input voltage range is universal, accommodating either 100 to 120 VAC nominal or 200 to 240 VAC nominal. The charger can provide up to 100 watts output for 18 seconds and 45 watts steady state indefinitely.

SurePower™ Battery

The SurePower™ Battery is designed to accommodate 3 (nominal output 12.3V) or 4 (nominal output 16.4V) series lithium-ion cells. It contains electronics that provide battery cell protection, SMBus communication, fuel gauging, and self-test functions. It also maintains a usage history for trending and diagnostic purposes. There are two modes of operation — active and sleep mode. Sleep mode minimizes drain on the battery cells during storage or prolonged periods of inactivity.

Parameter Power Supply (SpO_2, $EtCO_2$, NIBP)

The parameter power supply board provides power and communications for the Masimo SpO_2 module, the $EtCO_2$ Capnostat 5 sensor, and the Suntech Advantage A+ NIBP module. SpO_2 and $EtCO_2$ power and communications are isolated from the system to meet the requirements for applied parts in EN60601-1, EN60601-2-4 and EN60601-2-49. NIBP isolation requirements are met by the applied parts themselves; the cuffs and tubing are non-conductive.

A barometric pressure sensor is included for $EtCO_2$ monitoring. In addition, a hardware R wave trigger is routed from the digital system board to the NIBP module.

Digital System Board

The R Series Digital System Board is the main control unit of the R Series defibrillator. The digital system includes these major blocks:

- System Processor: SH3-DSP SH7229
- FLASH memory for program boot
- SDRAM for program and data storage
- USB Device and Host interfaces
- One compact flash interface
- Disk-On-Chip for non-removable data storage
- Display Controller: 8M RAM, LCD and VGA outputs
- CPLD for system control
- FPGA for I/O control and serial I/O
- CODEC for audio input (microphone: future) and output (speaker)
- ECG Out
- RS232 (internal use only)
- Beeper driver
- Strip Chart Printer controller and drivers
- Real time clock / calendar with precision crystal and battery
- Safety functions including watchdog, power monitors and reset control

The digital system board controls and/or communicates with external functional modules and real time peripherals including the core P/D Engine, core ECG, parameters (SpO_2, $EtCO_2$ and NIBP), CPR, AC charger, battery, and controls board.

Analog System Board

The R Series Analog System Board contains both the isolated Core ECG circuitry and the non-isolated power supplies, power management, and analog support functions for the R Series defibrillator.

Core ECG circuitry

The Core ECG circuit consists of both analog and digital circuitry. The ECG analog front end subsystem comprises two individually isolated and shielded sections:

- Multifunction (MFE)/Paddles Front End, and Patient Impedance Measurement.

  The MFE/Paddles section provides an ECG signal derived from the defibrillator pads/paddles for quick evaluation before and after defibrillation. This section also provides the means for the measurement of the patient's transthoracic impedance.

- Diagnostic/Monitoring ECG.

  The Diagnostic/Monitoring ECG section provides 3 Lead monitoring, 3 Lead monitoring while pacing (MwP), 5 Lead Diagnostic ECG, and 12/15/18 Lead diagnostic ECG (if this circuitry is populated). The front end detects the type of cable plugged in and configures itself accordingly.

The Core ECG digital circuitry is comprised of the following functionality:

- An isolated system interface for system clock synchronization, system communication, and programming ECG FLASH. System communication includes transmission of ECG data, transmission/reception of commands, status, and ECG cable identification. The ECG algorithm, including internal Sync Detect, is executed in the digital signal processor (DSP). Patient impedance is also processed by the DSP.

Analog support functions

In addition to the core ECG circuitry described above, the R Series Analog System Board contains DC power supplies, power management, and analog support functions for the R Series defibrillator. The major functional blocks are listed below and details can be found in 9301-0506-TO.

- 12 bit serial A/D module which includes battery monitoring, CPR monitoring, power supply monitoring, barometric pressure monitoring (for $EtCO_2$) and legacy R Series accessory identification
- Power supplies including 2VDD, S3VDD, S5VDD, -5VSS, 5V_L, V9P5 (printhead), isolated ECG_P1/ECG_P2 and isolated MFE_P1/MFE_P2 for the Core ECG module, and isolated V12P5 and 12VA for the Core P/D module
- Power management including reset and on/off logic
- Pathway for external sync input/output, analog ECG out, and for 1-wire identification of R Series electrodes

Pace/Defib Core Engine

The R Series P/D Core Engine is an independent module with its own controller. It generates pace and defib therapeutic energies when supplied with appropriate high power (10 - 15A @ 10V min - 18V max), low power (+12, +5, +3.3, -5), serial communication commands, and digital signals. Direct digital signals are provided to reduce timing delays on critical signals - an example is the SYNC signal used to synchronize the defibrillator pulse.

The module generates a rectilinear biphasic waveform, similar to that of the ZOLL M Series unit. The waveform is flatter, however, and, at high patient impedances, delivers higher current than the M Series. To accomplish this, the capacitor was changed from 115 uF @2300V to 100 uF @2800V. The defib pulse is generated from an SCR bridge, and shaped by a 6-element DAC. The module also contains pace generation circuits employing a tightly controlled current source, isolated from the patient by a transformer, and a relay.

This provides more accurate control of the pace current, and better isolation of the ECG from the defib charging circuit.

Front Panel Controls

The main rotary switch (full selection includes pace, off, monitor and defib modes) and pace encoders (amplitude and rate) are located on the front panel and connect to the controls board. The controls circuit also includes the following:

- Front panel switches: energy select, charge, shock, analyze, lead, size, alarm suspend, recorder, 4:1, 6 softkeys and NIBP
- Shock switch LEDs
- AC on and battery charge indicators
- Readiness indicator (green check or red X)
- Front panel type identification
- LED backlighting to distinguish basic life support (AED) mode from advanced life support (manual) mode

Peripherals

R Series peripherals include the following:

- Color TFT LCD with 640 X 480 resolution
- Printer (M Series legacy)
- Speaker (M Series legacy)
- Beeper (M Series legacy)
- USB for data communication
- Compact Flash for software loading and WiFi option

Accessories

R Series accessories include the following:

- All legacy M Series accessories (paddles, padz, internal handles, SpO_2, 3/5Lead ECG, NIBP cuffs, etc.)
- $EtCO_2$ Capnostat 5 sensor
- R Series unicables and R Series electrodes. The fully featured models support defib, pace, CPR, date code, condition sensor, defib self-test while pre-connected, and monitoring while pacing.
- Sync in/Sync out cable (Not sold by ZOLL. A third party makes this cable).
- USB cable (Not sold by ZOLL - compatible with standard USB cables)
- Printer paper

Power Management Support Functions

Charger Functions

When battery is fully charged, the charge current is terminated by setting the charger current PWM to less than 15%. The charger resumes supplying battery current when the SOC reaches 95% +/-1%.

R Series powers on when a battery is dropped-in if the loaded battery Voltage is above the hardware threshold (8.7V). Upon battery drop-in, charger current-limit is established on the basis of Battery conditions and DC bus Voltage. If the battery charge was recently terminated due to over-current, the charger FET is opened, and the replace battery is indicated.

Shut-down Functions

The software initiates the shutdown sequence (“replace battery”) when the Kelvin Battery A/D Voltage is 9.3V or at 600mA-hrs of remaining capacity, whichever occurs first. (Remaining capacity is read from the battery as a 16-bit unsigned quantity directly in mA-hrs).

The hardware will not shutdown if the input Voltage (at the switched-power node) is above 8.7V.

The software initiates “low battery” at an RTTE (run-time-to-empty) of 65 minutes. This is designed to allow 25 minutes of run-time until "replace battery" under nominal R Series operating conditions in monitor mode with no printer.

If the system shuts down due a slowly depleting battery, the R Series system requires user-intervention to turn back on. This could be due to battery drop-in or the front panel switch.

P/D Settings

The software attempts to establish a P/D setting that reflects an estimate of the battery ESR. This is to avoid shutdown due to loading of the DC bus. Tables have been prepared on the basis of nominal R Series operating conditions without the printer operating. We will rely on the defib module throttling to handle additional load conditions (such as printer).

Wi-Fi

The R Series offers the option for Wi-Fi data transmission of the full disclosure file (ECG waveforms, SpO_2 values, etc.), device check file (self test results), and activity log file. This is accomplished with an IEEE 802.11abgn Wi-Fi compact flash card that is inserted into the existing compact flash I/O port. Full disclosure transmissions can be sent (when properly configured) to a database management system called CodeNet Central that resides on a desktop or laptop computer. Device check and activity log transmissions will be sent to a ZOLL Data Systems application called Defib Dashboard. CodeNet Central is developed by ZOLL Data Systems.

Chapter 6
Test After Repair

Overview

The following tests are required after completing specific repairs on the ZOLL R 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 R Series
Impedance Calibration	• Digital board* • Analog board* • PD engine*
Power Supply Test	• Digital board* • AC power supply • Battery interconnect board

*This component should only be replaced by ZOLL or by a ZOLL Authorized Service Provider.

Power Supply Test

Note: Tests in this section will produce battery errors due to the use of a power supply in place of a SurePower Battery.

Equipment

- 2 red miniature alligator to miniature alligator leads
- 2 black miniature alligator to miniature alligator test leads
- DC power supply (15 Amp minimum)
- 0.1Ω resistor (¼W or greater)
- 1000Ω 1% ¼W resistor
- Fluke 75 multimeter or equivalent

Test Setup

1. Disconnect the AC line cord from the unit.
2. Make sure the unit and power supply are turned off.
3. Connect one end of the black lead to the "-" terminal in the battery well.
4. Connect the other end of the black lead to the "-" terminal of the power supply.
5. Connect the red lead to "+" terminal socket of the battery well. Use the middle pin with the plastic guard around it. Connect the other end of the red lead to the "+" terminal of the power supply.
6. Set the power supply voltage to 7V.

Caution Be sure to connect the power supply properly to the R Series battery well terminals or damage to the unit may result. Do NOT raise the power supply voltage above 15V.

	Do this...	Observe this...	Pass / Fail
1	Turn the selector switch to **MONITOR** (for AED units turn to ON.)	The unit should not turn on.	o o
2	Turn the unit off.		
3	Adjust the power supply voltage to 10.8V and turn the selector switch to **MONITOR**.	The unit should turn on. No *LOW BATTERY* message displays.	o o
4	Low Battery Test Set voltage to 10.5V.	*LOW BATTERY* message displays within 30 seconds.	o o
5	Set voltage to 10.2V.	*REPLACE BATTERY* message displays within 30 seconds.	o o
6	Turn the unit off.		

Test Setup

1. Remove red lead from power supply and connect to 0.1Ω resistor.
2. Connect other end of resistor to "+" terminal of power supply using a second red lead.
3. Connect multimeter across the resistor.
4. Set voltage scale (if DVM is not autoranging) to 220 mV.

	Do this...	Observe this...	Pass/Fail/N/A
7	System Current Test Set power supply to 10.8V.		
8	Turn the selector switch to **MONITOR**.	Voltage across resistor should be 145 mV or less (<1.2A of ON current). **Note:** Without optional parameters.	o o o
		All devices with SpO_2, $EtCO_2$ or NIBP <160mV	o o o
9	Turn unit off.		

Off Current Test

Test Setup

1. Remove 0.1Ω resistor and replace with 1KΩ.
2. Connect DMM across resistor.
3. Set voltage scale to DCV.
4. Measure voltage across resistor.

	Do this...	Observe this...	Pass/Fail
10	Off Current Test Measure across resistor with unit turned off.	Voltage should be less than 270 mV (<270 µA of current)	o o

Charger Test

Equipment 2-Post Battery Fixture (9100-0575-TF), DVM, 2 Test Leads, Impulse 4000, stopwatch

Test Setup
1. Set DVM to read DC Volts.
2. Connect Positive lead to positive post of the R Series charger load fixture.
3. Connect negative lead to negative post of the R Series charger load fixture.
4. Verify the unit is plugged into AC Power.

	Do this...	Observe this...	Pass/Fail
11	Set front panel switch to **DEFIB** or **ON** (for BLS units, press **MANUAL MODE**, then press **CONFIRM**).		
12	Install Charger Test Fixture		
13	Observe the voltage.	Verify the charger voltage is 11.97–12.43V.	o o
14	On the Test Fixture, set the switch the 20 Ohms.	Verify the charger voltage is 9.50–11.87V.	o o
15	On the Test Fixture, set the switch the 27 Ohms.	Verify the charger voltage is 11.97–12.43V.	o o
16	Remove the charger load Test Fixture.		
17	Connect the universal cable to the Impulse 4000.		
18	Press the **ENERGY SELECT UP ARROW** button until 200J is displayed.	Verify 200J is displayed.	o o
19	Press the **CHARGE** button and start timing with a stopwatch. Stop timing when the **SHOCK** button illuminates.	Verify charge time is between 3–10 seconds.	o o
20	Press the **ENERGY DOWN ARROW** button.	Verify the unit internally discharged.	o o

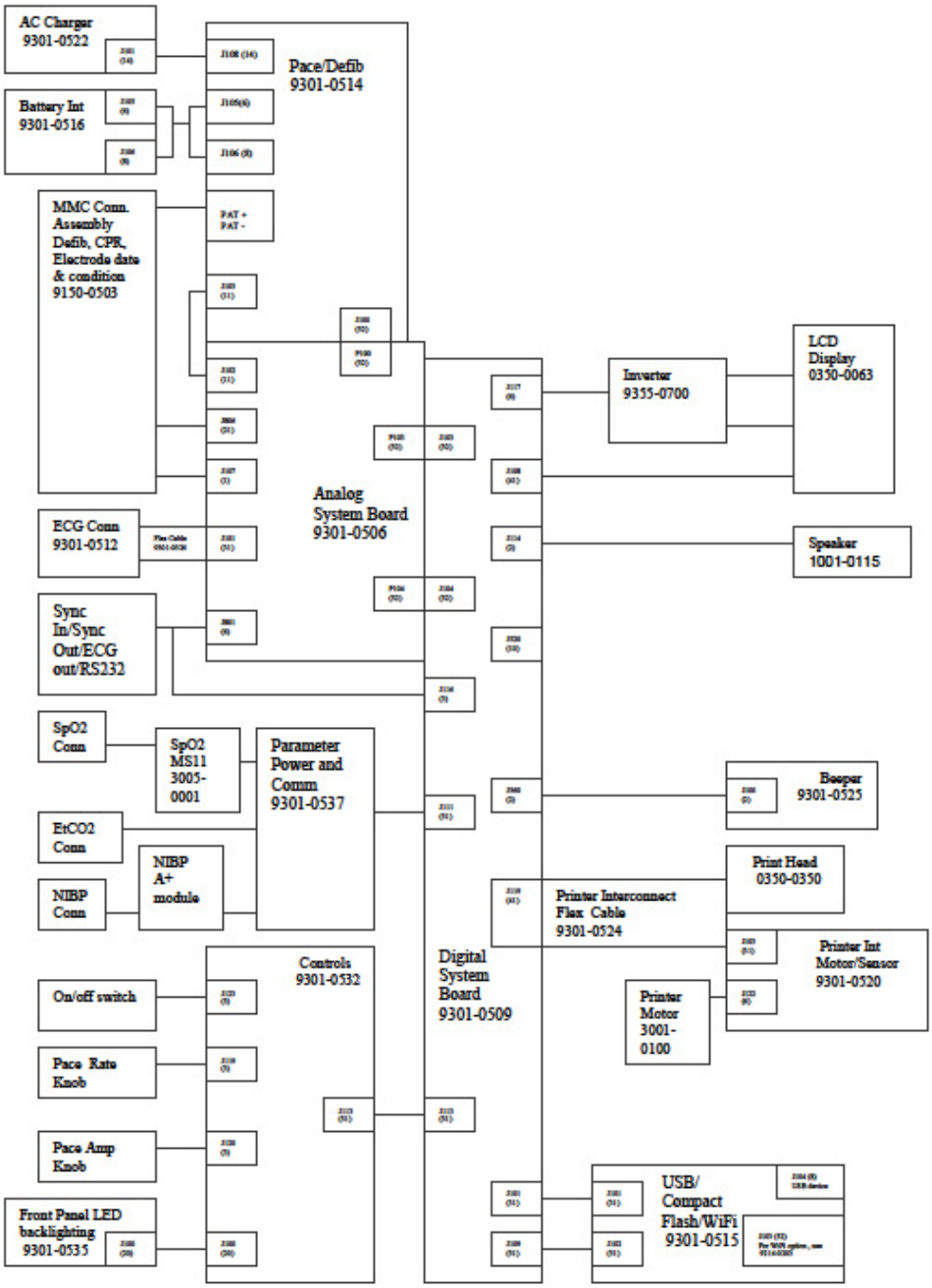
Appendix A

Overview

This appendix includes:

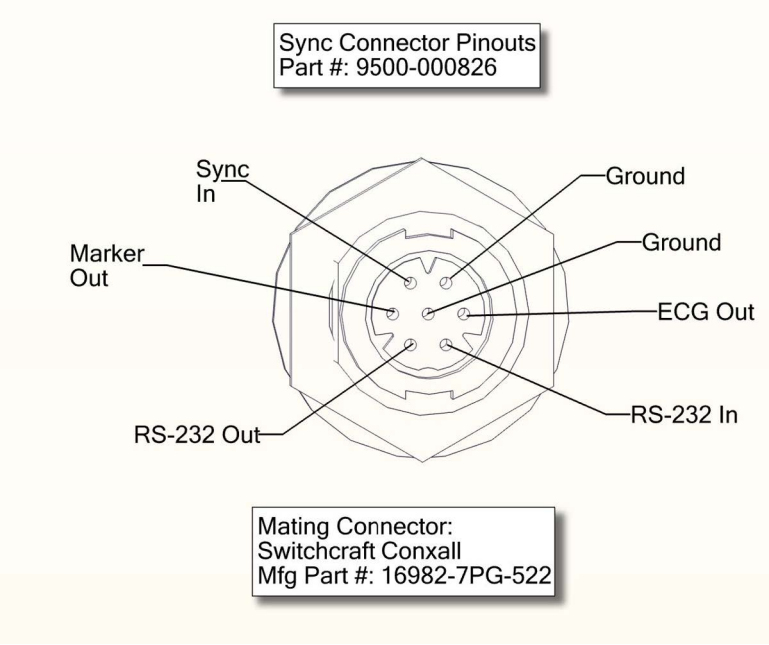
- Interconnect Diagram for the R Series Biphasic Unit
- Sync Connector Diagrams
- Delivered Energy at Every Defibrillator Setting into a Range of Loads
- Annual Inspection Checklist

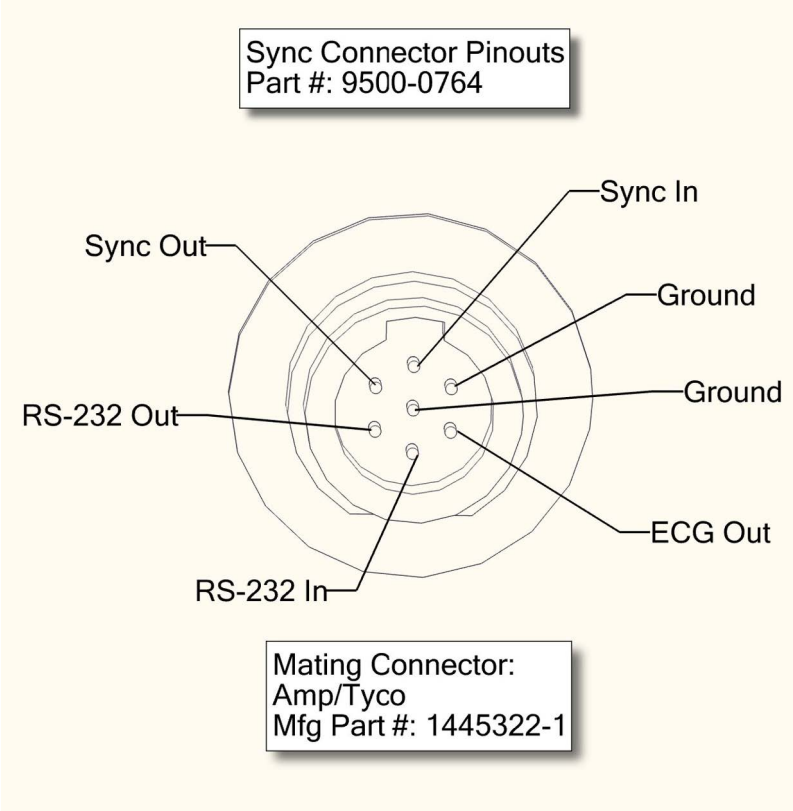
Interconnect Diagram for the R Series Biphasic Unit



Sync Connectors Diagram

There are two types of Sync Connectors. Below are the pin outs for each style.





Delivered Energy at Every Defibrillator Setting into a Range of Loads

Selected Energy	Load							Accuracy*
	25 Ω	50 Ω	75 Ω	100 Ω	125 Ω	150 Ω	175 Ω	
1	1 J	1 J	1 J	1 J	1 J	1 J	1 J	± 3J
2	1 J	2 J	2 J	2 J	2 J	2 J	2 J	
3	2 J	3 J	3 J	3 J	3 J	3 J	3 J	
4	3 J	4 J	4 J	5 J	5 J	5 J	4 J	
5	3 J	5 J	6 J	6 J	6 J	6 J	6 J	
6	4 J	6 J	7 J	7 J	7 J	7 J	7 J	
7	5 J	7 J	8 J	8 J	8 J	8 J	8 J	
8	5 J	8 J	9 J	9 J	10 J	9 J	9 J	
9	6 J	9 J	10 J	11 J	11 J	11 J	10 J	
10	7 J	10 J	12 J	12 J	12 J	12 J	12 J	
15	10 J	16 J	17 J	18 J	18 J	18 J	17 J	
20	14 J	21 J	23 J	24 J	24 J	24 J	23 J	
30	21 J	32 J	35 J	36 J	37 J	36 J	35 J	±15%
50	35 J	54 J	59 J	61 J	62 J	61 J	59 J	
70	49 J	76 J	83 J	85 J	87 J	86 J	83 J	
75	53 J	81 J	89 J	91 J	93 J	92 J	89 J	
85	60 J	92 J	101 J	104 J	106 J	104 J	101 J	
100	71 J	109 J	119 J	122 J	125 J	123 J	119 J	
120	85 J	131 J	143 J	147 J	150 J	147 J	143 J	
150	107 J	164 J	180 J	183 J	188 J	184 J	179 J	
200	142 J	230 J	249 J	253 J	269 J	261 J	260 J	

Annual Inspection Checklist

For your convenience, a standalone checklist tool exists which can be used to record the results of the maintenance test procedures (“ZOLL R Series Annual Inspection Checklist”, **REF** 5000-000903-FM). This checklist can be found by visiting *https://www.zoll.com/RSeriesInspection* or by scanning the QR code below with your mobile device. Note the maintenance test procedures in this service manual align with **Rev. B** of the checklist.

R Series Annual Inspection Checklist