NELLCOR

OxiMax NPB-40

Handheld Pulse Oximeter Service Manual

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Introduction

Warnings

Warnings are identified by the WARNING symbol shown above.

Warnings alert the user to potential serious outcomes (death, injury, or adverse events) to the patient or user.

WARNING: The sensor uses the date and time provided by the NPB-40 handheld pulse oximeter when the sensor event record is recorded by the sensor. The accuracy of the date/time is dependent on the date/time already set in and provided by the NPB-40.

WARNING: Explosion hazard. Do not use the NPB-40 in the presence of flammable anesthetics mixed with air, oxygen, or nitrous oxide.

WARNING: Do not spray, pour, or spill any liquid on the NPB-40, its accessories, connectors, switches, or openings in the chassis.

WARNING: The LCD panel contains toxic chemicals. Do not ingest chemicals from a broken LCD panel.

WARNING: The use of accessories, *OxiMax* sensors, and cables other than those specified may result in increased emission and/or decreased immunity of the NPB-40.

WARNING: Do not silence the NPB-40 audible alarm or decrease its volume if patient safety could be compromised.

Cautions

Cautions are identified by the CAUTION symbol shown above.

Cautions alert the user to exercise care necessary for the safe and effective use of the NPB-40.

Caution: Observe ESD (electrostatic discharge) precautions when working within the unit.

Caution: Observe ESD (electrostatic discharge) precautions when disassembling and reassembling the NPB-40 and when handling any of the components of the NPB-40.

Caution: When reassembling the NPB-40, tighten the screws that hold the cases together to a maximum of ten inch-pounds. Over-tightening could strip out the screw holes in the front case, rendering it unusable.

Caution: When installing the Power Supply or the User Interface PCB, tighten the seven screws to a maximum of four inch-pounds. Over-tightening could strip out the screw holes in the bottom case, rendering it unusable.

Notes

Notes are identified by the **Note** symbol shown above.

Notes provide useful helpful information.

Manual Overview

This manual contains information for service personnel who will service the Nellcor model *OxiMax* NPB-40 handheld pulse oximeter (herein referred to as the NPB-40). Only qualified service personnel should service this product. Read the operator's manual carefully and thoroughly understand the operation of the NPB-40.

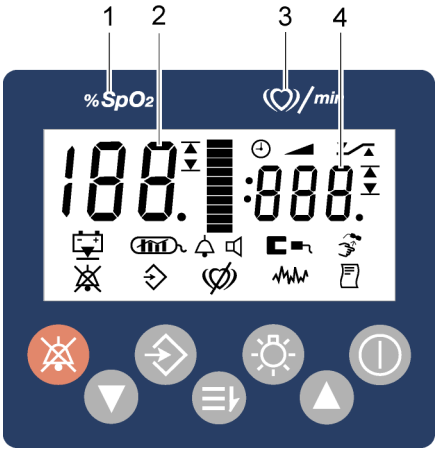
WARNING: Explosion hazard. Do not use the NPB-40 in the presence of flammable anesthetics mixed with air, oxygen, or nitrous oxide.

Description of NPB-40

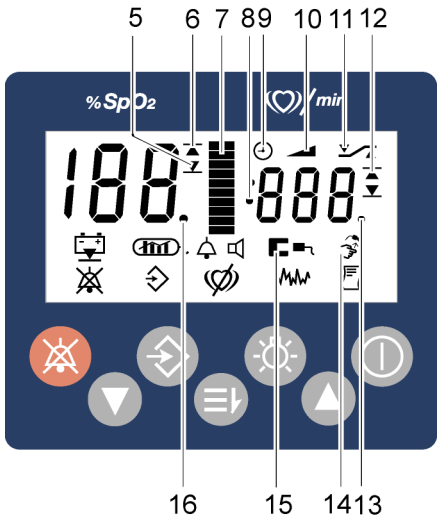
The *OxiMax* NPB-40 handheld pulse oximeter (herein referred to as the NPB-40) is indicated for non-invasive, spot-check measurements of functional arterial oxygen saturation (SpO_2) and pulse rate of adult, pediatric, and neonatal patients. It can be used in hospital, emergency, transport, and mobile environments, as well as in the home care environment.

Identification of Front Panel Buttons and Symbols

Refer to the NPB-40 Operator's manual for a complete description of all buttons, symbols, controls, displays and indicators.



1 — %SpO_2 area of display
2 — Measured %SpO_2
3 — Pulse beats per minute (bpm) area of display
4 — Measured bpm



5 — %SpO2 Lower Alarm Limit indicator

6 — %SpO2 Upper Alarm Limit indicator

7 — Pulse Amplitude indicator (blip bar)

8 — Time colon time/date field separator

9 — Adjust Time mode indicator

10 — Adjust Volume mode indicator

11 — Set Limit mode indicator

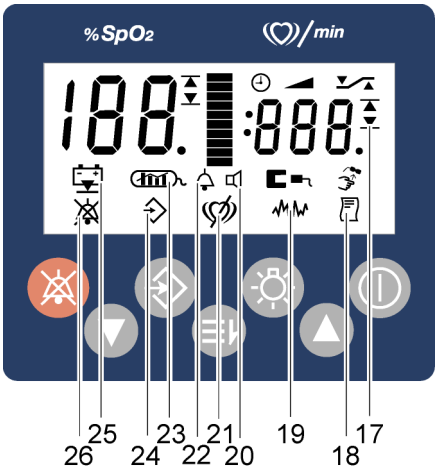
12 — BPM Upper Alarm Limit indicator

13 — BPM Limit Changed indicator

14 — Sensor Off Patient indicator

15 — Sensor Disconnected indicator

16 — %SpO2 Limit Changed indicator



17 — BPM Lower Alarm Limit indicator

18 — Print indicator

19 — Motion indicator

20 — Pulse Beep Tone Volume Adjust indicator

21 — Pulse Search indicator

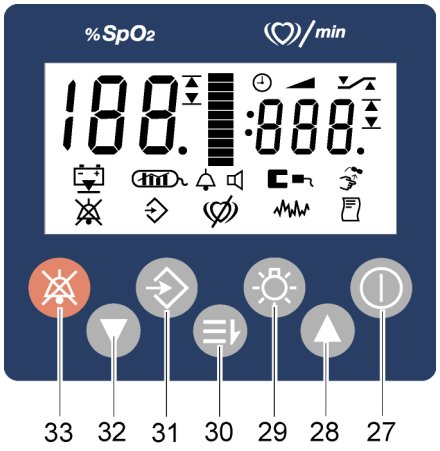
22 — Alarm Volume Adjust indicator

23 — Data In Sensor indicator

24 — Data indicator

25 — Low Battery indicator

26 — Alarm Silenced indicator



27 — Power button

28 — Up Arrow button

29 — Backlight button

30 — Menu button

31 — Data (record/print) button

32 — Down Arrow button

33 — Alarm Silence button

Function Menu

Pressing the Menu button repeatedly during normal operation sequentially shows seven parameter-setting displays, one for each button activation, and then returns to the default monitoring display. Settable parameters include high and low SpO_2 limits, high and low bpm limits, alarm volume, pulse beep volume, and data printing.

Pressing the Menu button during start-up Power-On Self-Test (POST) test accesses the Time/Date setting menu. Repeated activations of the Menu button in this menu sequence shows five time/date parameter-setting displays that allows the user to set Hour, Minute, Day, Month, and Year, and then return to the POST display.

Structure

Table 1: Menu Structure

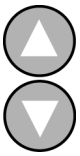
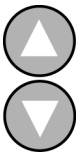
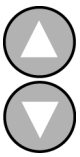
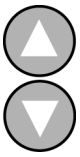
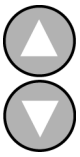
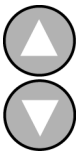
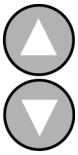
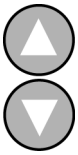
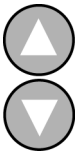
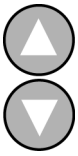
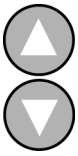
# of Presses	Parameter	Press	Function
1 	SpO_2 Low Limit		Adjust limit
2 	SpO_2 High Limit		Adjust limit
3 	BPM Low Limit		Adjust limit
4 	BPM High Limit		Adjust limit
5 	Pulse Beep Volume		Adjust volume. Indications on blip bar.
6 	Alarm Volume		Adjust volume. Indications on blip bar.
7 	Print Data		Print summary and/or stored snap-shot and sensor-event data.

Table 2: Time Set Menu

# of Presses	Parameter	Press	Function
The  must be pressed during the NPB-40 POST.			
1		Hour		Adjust 1 to 23
2		Minute		Adjust 1 to 59
3		Day		Adjust 1 to 31
4		Month		Adjust 1 to 12
5		Year		Adjust 2003 to 2099

When the month entry is made, the NPB-40 checks the day selection to see if it is correct. If the day selection is not valid for the month selected the NPB-40 display returns to the day selection display.

When the year entry is made, the NPB-40 checks the day and month selections to see if they are correct. If the day or month selection is not valid for the year selected the NPB-40 display returns to the day selection display.

Some examples of illegal dates are:

- 30 February
- 31 February

- 31 April
- 31 June
- 31 September
- 31 November
- 29 February on a non-leap year

Related Documents

To perform test and troubleshooting procedures and to understand the principles of operation and circuit analysis sections of this manual, you must know how to operate the NPB-40. Refer to the NPB-40 operator's manual. To understand the various Nellcor approved *OxiMax* sensors that work with the NPB-40, refer to the individual *OxiMax* sensor's Directions For Use.

The latest version of the operator's manual and the service manual are posted on the Internet at:

http://www.mallinckrodt.com/respiratory/resp/Serv_Supp/ProductManuals.html

Spare Parts and Accessories are posted on the Internet at:

http://www.mallinckrodt.com/respiratory/resp/Serv_Supp/Apartweb/main/PartAcceMenu.html

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Routine Maintenance

Cleaning

WARNING: Do not spray, pour, or spill any liquid on the NPB-40, its accessories, connectors, switches, or openings.

For *surface-cleaning* and *disinfecting* follow your institution's procedures or:

- The NPB-40 may be *surface-cleaned* by using a soft cloth dampened with either a commercial, nonabrasive cleaner or a solution of 70 percent alcohol in water, and lightly wiping the surfaces of the NPB-40.
- The NPB-40 may be *disinfected* using a soft cloth saturated with a ten percent solution of chlorine bleach in tap water.

Before attempting to clean an SpO_2 *OxiMax* sensor, read the Directions For Use enclosed with the *OxiMax* sensor. Each sensor model has cleaning instructions specific to that sensor.

Periodic Safety Checks

The NPB-40 requires no calibration.

The following checks should be performed at least every 24 months by a qualified service technician.

1. Inspect the equipment for mechanical and functional damage.

2. Inspect safety labels for legibility. If the labels are damaged, contact Nellcor's Technical Services Department, 1.800.635.5267, or your local Nellcor representative.

Functional Checks

If the NPB-40 has been visibly damaged or subjected to mechanical shock (for example, if dropped), immediately perform the performance tests. See *Performance Tests* on page 15.

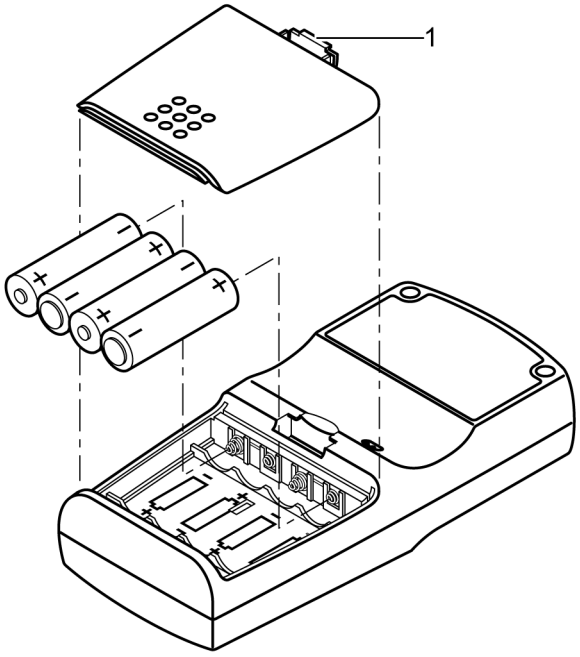
The following check should be performed at least every two years by a qualified service technician.

- Perform the electrical safety tests detailed in *Safety Tests* on page 31. If the unit fails these electrical safety tests, refer to *Troubleshooting* on page 33.

Battery Installation

Caution: The NPB-40 does not operate with dead batteries. Install new batteries.

1. Press Power to turn the NPB-40 off.
2. Pull the battery compartment latch downward, toward the bottom of the NPB-40, and remove the battery access door. See Figure 1.
3. Install four “AA” size batteries, orientated as shown in Figure 1.
4. Replace the battery access door.



1 — Battery compartment latch

Figure 1: Installing Batteries

WARNING: Explosion hazard. Do not use the NPB-40 in the presence of flammable anesthetics mixed with air, oxygen, or nitrous oxide.

WARNING: To ensure patient safety, do not place the in any position that might cause it to fall on the patient.

WARNING: As with all medical equipment, carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.

WARNING: To ensure accurate performance and prevent device failure, do not expose the NPB-40 to extreme moisture such as rain.

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Performance Verification

Introduction

This section discusses the tests used to verify performance following repairs or during routine maintenance. All tests can be performed without removing the NPB-40 cover. All tests except the battery charge and battery performance tests must be performed as the last operation before the NPB-40 is returned to the user.

If the NPB-40 fails to perform as specified in any test, repairs must be made to correct the problem before the NPB-40 is returned to the user.

Equipment Needed

Equipment	Description
Digital Multimeter (DMM)	Fluke Model 87 or equivalent
Durasensor® *OxiMax* oxygen sensor	DS-100A
OxiMax oxygen sensor	MAX-A
Safety Analyzer	Must meet current AAMI ESI/1993 & IEC 60601-1/1998 specifications
Extension cable	DEC-4
Stopwatch	Manual or electronic
Nellcor model SRC-MAX Tester	Provides testing for *OxiMax* compatible monitors

Performance Tests

The power-up performance test verifies that the NPB-40 is ready for patient monitoring.

Power-On Self-Test

Discussion

Before using the NPB-40, you must verify that the NPB-40 is working properly and is safe to use. Proper working conditions are verified each time the NPB-40 is turned on as described in the following procedure. The verification procedure (POST) takes 7 to 13 seconds to complete.

Caution: If any indicator or display element does not light when the NPB-40 is turned on, do not use the NPB-40. Instead, contact qualified service personnel, your local Nellcor representative, or Nellcor's Technical Services Department.

Note: Physiological conditions, medical procedures, or external agents that may interfere with the NPB-40's ability to detect and show measurements, include dysfunctional hemoglobin, arterial dyes, low perfusion, dark

pigment, and externally applied coloring agents such as nail polish, dye, or pigmented cream.

Note: The NPB-40 automatically starts the Power-On Self-Test (POST), which tests the NPB-40 circuitry and functions.

Caution: During POST (immediately after power-up), confirm that all display segments and icons are shown, and the NPB-40 speaker sounds a one-second tone.

When the NPB-40 is turned on, the backlight remains on, the display shows the following sequence, in order, as POST takes place:

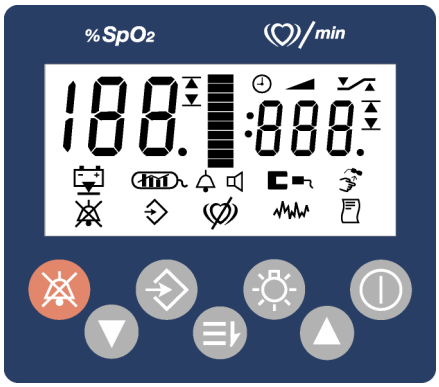
- Display graphics are shown for three seconds
- Display goes blank (all display elements off) for one second
- Version number of the software is shown as a three digit number in the right hand number field (with leading zeros if the version number is less than 100) and two dashes in the left-hand number field for three seconds
- Current time of day, using a 24-hour clock format is shown for three seconds
- Successful completion of the POST is announced by a POST Pass tone. (A failed POST is announced by a high-priority alarm tone.

Procedure

1. Turn on the NPB-40 by pressing the Power button.

Note: The backlight remains on during POST.

2. All display numbers and icons are shown for three seconds. The backlight is turned on.



3. The display goes blank for one second.

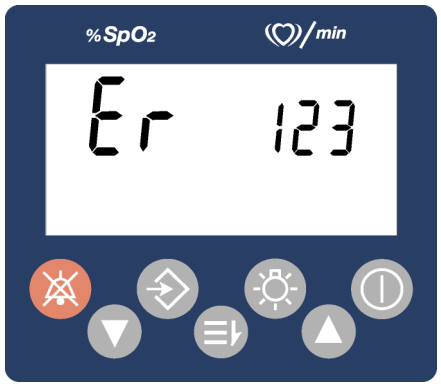
4. The software version number is shown for three seconds. The software version is identified by two dashes in the %SpO2 area of the display. The software version number is shown with leading zeros for software version numbers less than 100.

Note: The software version shown above is only a sample. Check your NPB-40 for the software version installed.

Note: Software version numbers are often needed when calling Nellcor's Technical Services Department or your local Nellcor representative for technical assistance. Write down the software version number and have it available prior to requesting technical assistance.

5. The current time is shown in a 24-hour format.

6. If the NPB-40 detects an internal problem during POST, an error tone sounds and the NPB-40 shows an error code (Er) and the corresponding error number (see *Troubleshooting* on page 33).



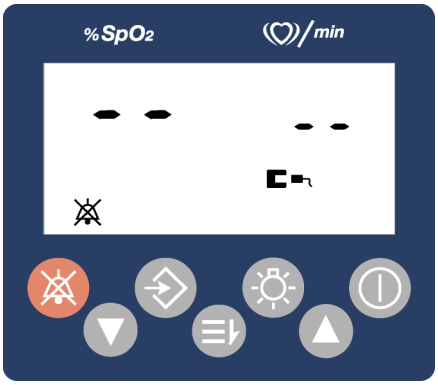
7. Upon successful completion of the POST, the NPB-40 sounds a one-second tone indicating that the NPB-40 has passed the test.

WARNING: If you do not hear the POST pass tone, do not use the NPB-40.

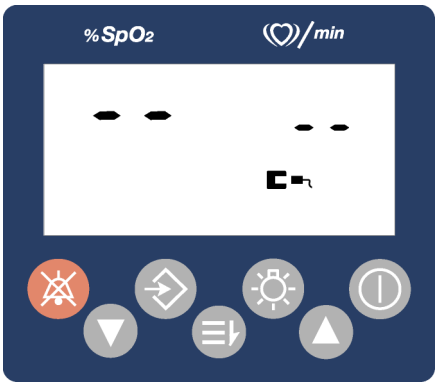
WARNING: Ensure that the speaker is clear of any obstructions and that the speaker holes are not covered. Failure to do so could result in an inaudible alarm tone.

Note: In addition to serving as the POST pass verification, the POST pass tone also functions as an audible confirmation that the speaker is performing properly. If the speaker does not function, the alarm warning sounds cannot be heard.

8. Press the Alarm Silence button. The Alarm Silenced indicator is displayed.



9. Press the Alarm Silence button. The Alarm Silenced indicator is not displayed.



10. Press the Backlight button. The backlight turns on.

11. Press the Backlight button. The backlight turns off.

Operational Setup

The operational setup procedure sets the time and date into the NPB-40. Refer to the NPB-40 Operator's manual for individual parameter settings. The NPB-40 returns to the factory default settings when it is powered on and individual parameter settings need to be set at that time.

Setting the Time and Date

Discussion

WARNING: The sensor uses the date and time provided by the NPB-40 handheld pulse oximeter when the sensor event record is recorded by the sensor. The accuracy of the date/time is dependent on the date/time already set in and provided by the NPB-40.

Note: Allowing the NPB-40 to time-out (30 seconds) sets the currently shown parameter and the NPB-40 display returns to the normal operating display.

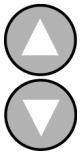
Procedure

With the NPB-40 in the normal monitoring mode:

1. Press the Power button to turn the NPB-40 Off.
2. Press the Power button to turn the NPB-40 On.
3. Press the Menu button during the POST operation until the set hours window is shown with the hours indication (13) flashing.

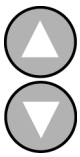
4. Press the Up Arrow button or the Down Arrow button until the desired hours are shown.

5. Press the Menu button to set the hours and show the minutes set display. The minutes indication (45) flashes.



6. Press the Up Arrow button or the Down Arrow button until the desired minutes are shown.

7. Press the Menu button to set the minutes and show the day set display. The day indication (29) flashes.



8. Press the Up Arrow button or the Down Arrow button until the desired day is shown.

9. Press the Menu button to set the day and show the month set display. The month indication (7) flashes.

10. Press the Up Arrow button or the Down Arrow button until the desired month is shown.

11. Press the Menu button to set the month and show the year set display. The year indication (2004) flashes.

12. Press the Up Arrow button or the Down Arrow button until the desired year is shown.

13. Press the Menu button to set the year and return to normal operation.

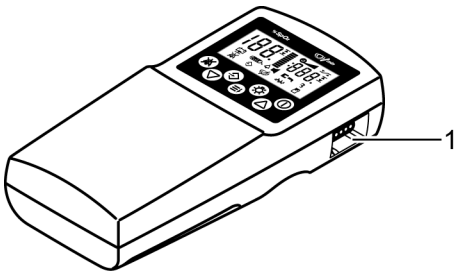
General Operation

The following test is an overall performance check of the system:

- *Operation with a Live Subject* on page 23.

Operation with a Live Subject

Patient monitoring involves connecting the *OxiMax* sensor to a live subject for a qualitative test.



1 — Sensor Port

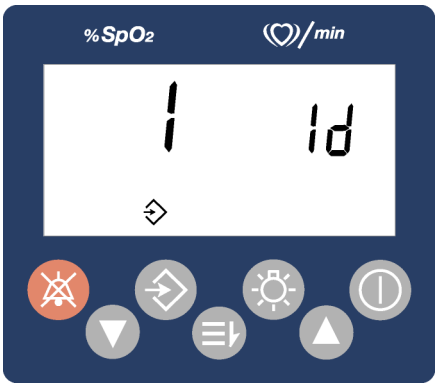
1. Connect a Nellcor *OxiMax* MAX-A oxygen *OxiMax* sensor to the NPB-40.

2. Clip the MAX-A to the subject as recommended in the *OxiMax* sensor's Directions For Use.

3. Press the Power button to turn the NPB-40 on and verify that the NPB-40 is operating.

4. The NPB-40 should stabilize on the subject's physiological signal in about 15 to 30 seconds. Verify that the oxygen saturation and pulse rate values are reasonable for the subject.

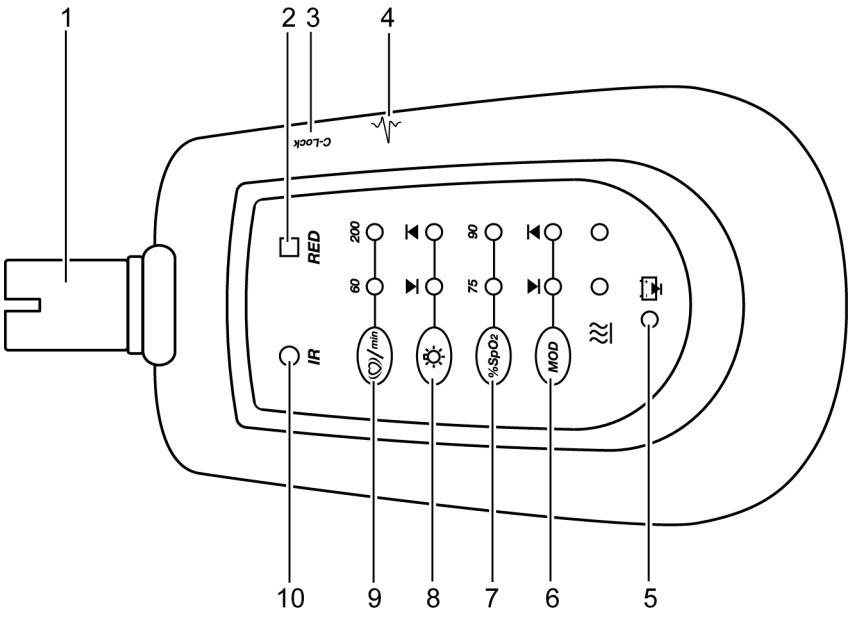
5. Press the Data button. The NPB-40 records snap-shot data.



Pulse Oximetry Functional Tests

These tests utilize the pulse oximetry functional tester (Nellcor model SRC-MAX) to verify the performance of the NPB-40. See Figure 2.

These tests should be done in sequence.



1 — NPB-40 Cable Connector	6 — % Modulation Select Button
2 — RED LED Drive Indicator	7 — % SpO_2 Select Button
3 — Not Used For NPB-40	8 — Light Level Selection Button
4 — Not Used For NPB-40	9 — Pulse Rate Selection Button
5 — Battery Low Indicator	10 — INFRARED LED Drive Indicator

Figure 2: SRC-MAX *OxiMax* Oximetry Tester

Introduction

The SRC-MAX functional tester allows qualified technicians to functionally test Nellcor *OxiMax* technology-based pulse oximeters and OEM *OxiMax* technology-based monitors. The technician must perform the test setup procedure before performing tests 1 through 4. The following is a brief description of each test:

- **Test Setup** — This procedure establishes the baseline for all the other tests. The Test Setup procedure must be performed before performing any or all of the SRC-MAX tests.

- **Test 1: BPM** — This procedure simulates an *OxiMax* sensor attached to a patient indicating 60 bpm and 200 bpm. The test setup procedure sets up Test 1 for 60 bpm.

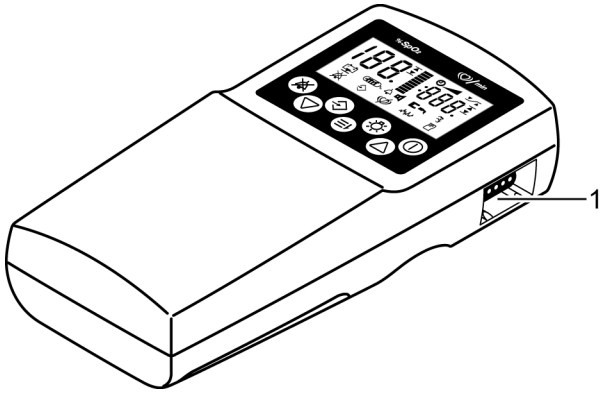
- **Test 2: SpO_2** — This procedure simulates an *OxiMax* sensor attached to a patient, indicating 75 percent blood oxygen saturation and 90 percent

blood oxygen saturation. The test setup procedure sets up Test 2 for 75 percent blood oxygen saturation.

- **Test 3: Modulation** — This procedure simulates an *OxiMax* sensor attached to a patient indicating low and high pulse strength. The test setup procedure sets up Test 3 for low pulse strength.

- **Test 4: Light** — This procedure simulates an *OxiMax* sensor attached to a patient indicating low and high light level passing through the patient at the sensor site. The test setup procedure sets up Test 4 for low light level.

Test Setup



1 — Sensor Port

Note: A DEC-4 extension cable may be used between the SRC-MAX and the NPB-40.

1. Connect the SRC-MAX tester to the NPB-40 sensor port.

2. Turn on the NPB-40 by pressing the Power button.

3. After the NPB-40 completes POST, the NPB-40:

   - Is in SpO_2 alarm
   - Shows an %SpO_2 of 75 (pass criteria is 73 to 77 %SpO_2 inclusive)
   - Shows a pulse rate of 60 (pass criteria is 57 to 63 bpm inclusive)

- Pulse Amplitude indicator - show low level modulation (low amplitude pulse amplitude indicator)

Test #1: BPM

1. Press the SRC-MAX % PULSE RATE selection button. The SRC-MAX PULSE RATE 200 LED lights.

2. The NPB-40 bpm increases to 200 and stabilize at 200 bpm. The test pass criteria is 197 to 203 bpm inclusive.

3. The NPB-40:

   - displays 75 %SpO2
   - displays 200 bpm (pass criteria is 197 to 203 bpm inclusive)
   - alarms
   - Pulse Amplitude indicator displays low level modulation

4. Press the SRC-MAX PULSE RATE select button. The SRC-MAX PULSE RATE 60 LED lights.

5. The NPB-40 pulse rate decreases to 60 and stabilize at 60 bpm. The test pass criteria is 57 to 63 bpm inclusive.

6. The NPB-40:

   - displays 75 %SpO2
   - displays 60 bpm (test pass criteria is 57 to 63 bpm inclusive)
   - alarms
   - Pulse Amplitude indicator displays low level modulation

Test #2: SpO2

1. Press the SRC-MAX %SpO2 select button. The SRC-MAX %SpO2 90 LED lights.

2. The NPB-40 displays three dashes until the SRC-MAX stabilizes at 90 %SpO2. The test pass criteria is 88 to 92 %SpO2 inclusive.

3. The NPB-40:

   - displays 90 %SpO2 (pass criteria is 88 to 92 %SpO2 inclusive)
   - displays 60 bpm
   - alarms
   - Pulse Amplitude indicator displays low level modulation

4. Press the SRC-MAX %SpO2 select button. The SRC-MAX %SpO2 75 LED lights.

5. The NPB-40 shows two dashes until the SRC-MAX stabilizes at 75 %SpO_2. The test pass criteria is 73 to 77 %SpO_2 inclusive.

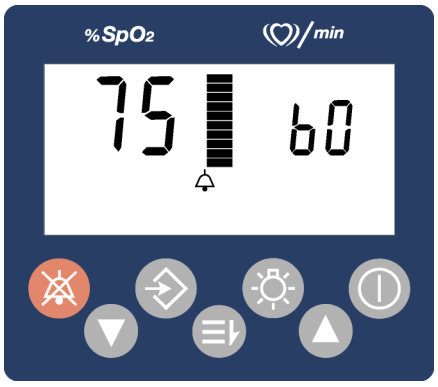
6. The NPB-40:

   - displays 75 %SpO_2 (pass criteria is 73 to 77 %SpO_2 inclusive)
   - displays 60 bpm
   - alarms
   - Pulse Amplitude indicator displays low level modulation

Test #3: Modulation Level

1. Press the SRC-MAX % MODULATION selection button. The SRC-MAX % MODULATION ▲ LED lights.

2. The NPB-40 pulse blip bar initially increases in amplitude and then stabilizes.



3. The NPB-40:

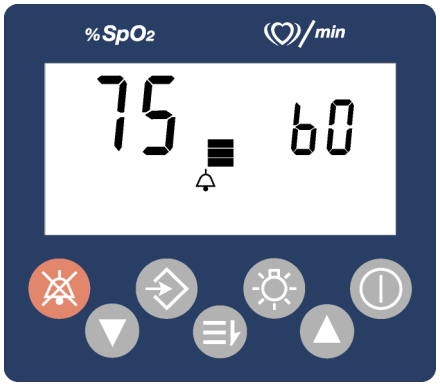
   - displays 75 %SpO_2 (test pass criteria is 73 to 77 %SpO_2 inclusive)
   - displays 60 bpm (test pass criteria is 57 to 63 bpm inclusive)
   - alarms
   - Pulse Amplitude indicator displays high level modulation

4. Perform *Test #1: BPM* on page 26. The Pulse Amplitude indicator should indicate high level modulation.

5. Perform *Test #2: SpO2* on page 27. The Pulse Amplitude indicator should indicate high level modulation.

6. Press the SRC-MAX % MODULATION selection button. The SRC-MAX % MODULATION ▼ LED lights.

7. The NPB-40 pulse blip bar decreases in amplitude.



8. The NPB-40:

   - displays 75 %SpO2
   - displays 60 bpm
   - alarms
   - Pulse Amplitude indicator displays low level modulation

9. Perform *Test #1: BPM* on page 26. The pulse amplitue indicator should indicate low level modulation.

10. Perform *Test #2: SpO2* on page 27. The pulse amplitue indicator should indicate low level modulation.

Test #4: Light Level

1. Press the SRC-MAX LIGHT LEVEL selection button. The SRC-MAX LIGHT LEVEL ▲ LED lights.

2. The NPB-40 pulse blip bar initially increases in amplitude and then stabilize.

3. The NPB-40

   - displays 75 %SpO2 (test pass criteria is 73 to 77 %SpO2 inclusive)
   - displays 60 bpm (test pass criteria is 57 to 63 bpm inclusive)
   - alarms
   - pulse amplitue indicator displays high level modulation

4. Perform *Test #1: BPM* on page 26. The pulse amplitue indicator should indicate high level modulation.

5. Perform *Test #2: SpO2* on page 27. The pulse amplitue indicator should indicate high level modulation.

6. Press the SRC-MAX LIGHT LEVEL selection button. The SRC-MAX LIGHT LEVEL ▼ LED lights.

7. The NPB-40 pulse blip bar decreases in amplitude.

8. The NPB-40:

   - displays 75 %SpO2
   - displays 60 bpm
   - alarms

- pulse amplitue indicator displays low level modulation

9. Perform *Test #1: BPM* on page 26. The pulse amplitue indicator should indicate low level modulation.

10. Perform *Test #2: SpO2* on page 27. The pulse amplitue indicator should indicate low level modulation.

11. Disconnect all equipment and turn off the NPB-40.

Safety Tests

The NPB-40 safety tests meet the standards of, and are performed in accordance with, EN 60601-1: 1990 (A1 and A2), IEC 60601-1, UL 60601-1, and CAN/CSA C22.2 No. 601.1. This product is categorized as internally powered type BF equipment.

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Troubleshooting

Introduction

This section explains how to troubleshoot the NPB-40. Tables list possible NPB-40 difficulties, along with probable causes, and recommended actions to correct the difficulty.

How To Use This Section

Use this section in conjunction with *Performance Verification* on page 15, and *Spare Parts* on page 55. To remove and replace a part suspected of being defective, follow the instructions in *Disassembly Guide* on page 43. The circuit analysis section in the *Technical Discussion* on page 75, offers information on how the NPB-40 functions.

Who Should Perform Repairs

Only qualified service personnel should open the NPB-40 housing, remove and replace components, or make adjustments. If your medical facility does not have qualified service personnel, contact Nellcor's Technical Services or your local Nellcor representative.

Troubleshooting Guide

Note: Follow the recommended actions discussed in this section to correct the majority of problems you may encounter. However, problems not covered here can be resolved by calling Nellcor's Technical Services or your local Nellcor representative.

If you encounter a problem that cannot be resolved through a visual inspection, refer to Table 3 which provides troubleshooting support. It is recommended that corrective actions be performed in the order presented. For a symptom that is not listed in Table 3, contact the Nellcor Technical Services Department at 1.800.635.5267 or your local Nellcor representative.

If an error code is shown on the NPB-40 front panel display, see Figure 3,turn the NPB-40 off, wait ten seconds, then turn the NPB-40 on. This clears recoverable errors encountered by the NPB-40. If the error code still persists, refer to Table 4 for the indicated failure.

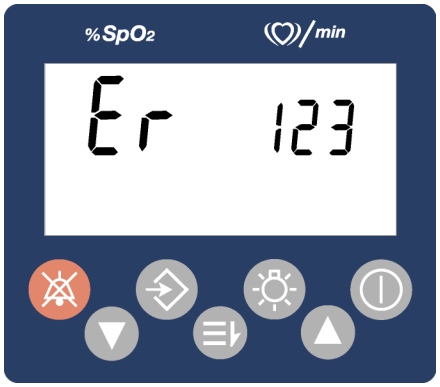

Figure 3: Typical Error Code Display

Once you have performed the recommended action, reassemble the NPB-40, refer to *Performance Verification* on page 15, and conduct a performance verification before returning the NPB-40 to service. If the symptom persists continue troubleshooting.

Table 3: Troubleshooting Guide

Condition	Recommended Actione
The NPB-40 does not turn on when the Power button is pressed.	
• The Power button was not fully depressed.	Fully press the Power button.
• The batteries are missing.	Open the battery compartment and if batteries are missing install new batteries. Refer to the NPB-40 Operator's manual.
• The batteries are installed incorrectly or they are backwards.	Open the battery compartment and if batteries are not installed correctly, remove and reinstall the batteries. Refer to the NPB-40 Operator's manual.
• The batteries are at or near a voltage too low for the NPB-40 to operate.	Install new batteries. Refer to the NPB-40 Operator's manual.
• The sensor is defective.	Replace the sensor.
• The front panel keypad is defective.	**Caution: Unlock J3 before attempting to remove flex circuit conductor.** Open the NPB-40, disconnect the front case from J3 on the CPU PCB and connect an ohmmeter between the flex circuit conductor for J3, pin 5 and the conductor for J3, pin 3. Observe a short when the Power button is pressed and an open when not pressed. If incorrect, replace the front case. See *Front Case Assembly Replacement* on page 49. If the Power button functions correctly, replace CPU PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• Flex circuit between the front panel and the CPU PCB is disconnected.	Inspect the flex circuit and reconnect if the flex circuit is loose. See *Separating the Front and Back Cases* on page 44.

Table 3: Troubleshooting Guide (Continued)

Condition	Recommended Actione
• A CPU PCB Component has failed.	Inspect the CPU PCB components and circuit board for cracking, burning, or damage and replace the CPU PCB if any are found. See *CPU PCB or Display PCB Replacement* on page 46.
One or more keys on the front panel keypad does not work.	
• The front panel keypad is defective.	**Caution: Unlock J3 before attempting to remove flex circuit conductor.** Open the NPB-40, disconnect the front case from J3 on the CPU PCB and connect an ohmmeter lead to the flex circuit conductor for J3, pin 3 and individually connect the other ohmmeter lead to each conductor for the buttons. Refer to the front panel schematic diagram (**). Observe a short when the button is pressed and an open when the button is not pressed. If incorrect, replace the front case. See *Front Case Assembly Replacement* on page 49. If correct, replace the CPU PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• Flex circuit between the front panel and the CPU PCB is disconnected.	Inspect the flex circuit and reconnect if the flex circuit is loose. See *Separating the Front and Back Cases* on page 44.
• A CPU PCB Component has failed.	Inspect the CPU PCB components and circuit board for cracking, burning, or damage and replace the CPU PCB if any are found. See *CPU PCB or Display PCB Replacement* on page 46.
• CPU PC has failed.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
One or more display segments does not work.	
• A display PCB component has failed.	Inspect the Display PCB for cracking, burning, or damage and replace the Display PCB if any damage is found. See *CPU PCB or Display PCB Replacement* on page 46.
• The Display PCB is defective.	Replace the Display PCB if any damage is found. See *CPU PCB or Display PCB Replacement* on page 46.
The speaker does not sound for pulse rate or alarms.	
• The speaker is turned off.	Turn the NPB-40 off then on.
• The holes for the speaker on the back of the NPB-40 are blocked.	Clear the holes for the speaker on the back of the NPB-40.
• The external output port on the CPU PCB has failed.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• The speaker on the Display PCB has failed.	Replace the Display PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
Pulse rate and %SpO_2 value is not shown and the NPB-40 is turned on.	
• The SpO_2 sensor is not connected properly.	Connect the SpO_2 sensor to the NPB-40. Connect the SpO_2 sensor to the patient. See the sensor Directions for Use.
• The SpO_2 sensor has failed.	Replace the SpO_2 sensor with a known good sensor.
• The Display PCB is defective.	Replace the Display PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.

Table 3: Troubleshooting Guide (Continued)

Condition	Recommended Actione
• The CPU PCB is defective.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
The display backlight does not come on when the Backlight button is pressed.	
• The **Backlight** bottom on the front panel keypad is defective.	**Caution: Unlock J3 before attempting to remove flex circuit conductor.** Open the NPB-40, disconnect the front case from J3 on the CPU PCB and connect an ohmmeter lead to the flex circuit conductor for J3, pin 3 and individually connect the other ohmmeter lead to each conductor for the buttons. Refer to the front panel schematic diagram (**). Observe a short when the button is pressed and an open when the button is not pressed. If incorrect, replace the front case. See *Front Case Assembly Replacement* on page 49. If correct, replace the CPU PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• Flex circuit between the front panel and the CPU PCB is disconnected.	Inspect the flex circuit and reconnect if the flex circuit is loose. See *Separating the Front and Back Cases* on page 44.
• A CPU PCB Component has failed.	Inspect the CPU PCB components and circuit board for cracking, burning, or damage and replace the CPU PCB if any are found. See *CPU PCB or Display PCB Replacement* on page 46.
• CPU PC has failed.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• The Backlight LEDs on the Display PCB have failed.	Replace the Display PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
The NPB-40 shuts off when the Backlight button is pressed.	
• The batteries are at or near a voltage too low for the NPB-40 to operate.	Install new batteries. See the NPB-40 Operator's manual.
The printer does not print.	
• The printer and the NPB-40 are not properly aligned.	Align the printer and the NPB-40. See the NPB40 Operator's manual.
• The printer is turned off.	Turn the printer on. See the printer documentation.
• The Data bottom on the front panel keypad is defective.	**Caution: Unlock J3 before attempting to remove flex circuit conductor.** Open the NPB-40, disconnect the front case from J3 on the CPU PCB and connect an ohmmeter lead to the flex circuit conductor for J3, pin 3 and individually connect the other ohmmeter lead to each conductor for the buttons. Refer to the front panel schematic diagram (**). Observe a short when the button is pressed and an open when the button is not pressed. If incorrect, replace the front case. See *Front Case Assembly Replacement* on page 49. If correct, replace the CPU PCB. See *CPU PCB or Display PCB Replacement* on page 46.

Table 3: Troubleshooting Guide (Continued)

Condition	Recommended Actione
• Flex circuit between the front panel and the CPU PCB is disconnected.	Inspect the flex circuit and reconnect if the flex circuit is loose. See *Separating the Front and Back Cases* on page 44.
• A CPU PCB Component has failed.	Inspect the CPU PCB components and circuit board for cracking, burning, or damage and replace the CPU PCB if any are found. See *CPU PCB or Display PCB Replacement* on page 46.
• CPU PC has failed.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• The printer batteries are at or near a voltage too low to operate the printer.	Install new batteries in the printer. See the printer documentation.
• The Display PCB has failed.	Replace the Display PCB with a known good PCB.See *CPU PCB or Display PCB Replacement* on page 46.
• The CPU PCB has failed.	Replace the CPU PCB with a known good PCB. See *CPU PCB or Display PCB Replacement* on page 46.
• The printer is defective.	Attempt to print using a known good NPB-40. If the printer still does not print, troubleshoot the printer. See the printer documentation.

Error Codes

An error code is shown when the NPB-40 detects a non-correctable failure. Table 4 provides a list of error codes for the NPB-40. When one of the following errors occurs:

- NPB-40 sounds a low priority alarm
- Measurements stop
- “Er” is shown in the %SpO2 numeric display area
- Error code is shown in the right numeric display
- Cycling the power should clear the shown error code

Table 4 provides a list of error codes for the NPB-40.

Table 4: Error Codes

Error Code	Scope of Action			Action	Explanation
	Clinician	Repair	Return		
1		X		Replace SpO2 board.	SpO2 front end RAM error.
2		X		Replace SpO2 board.	SpO2 front end ROM/code integrity error.
3		X		Replace SpO2 board.	SpO2 front end reported a bad CRC.
4		X		Replace SpO2 board.	SpO2 front end reported FSP message not allowed.

Table 4: Error Codes (Continued)

Error Code	Scope of Action			Action	Explanation
	Clinician	Repair	Return		
5		X		Replace SpO2 board.	SpO2 front end reported illegal value sent in FSP message.
6		X		Replace SpO2 board.	SpO2 front end reports calibration (offset) failure.
9		X		Replace SpO2 board.	SpO2 front end reported syntax error in FSP message.
10		X		Replace SpO2 board. Check extension cable, SRC Max.	Over-current limit in SpO2 front end has tripped.
11	1	2		1 — Replace batteries. 2 — Replace SpO2 board.	SpO2 front end reports incorrect system voltage.
12		X		Replace SpO2 board.	SpO2 front end reports other hardware problem.
14		X		Replace SpO2 board.	SpO2 front end reports communication channel overflow.
16		X		Replace SpO2 board.	SpO2 front end reports watchdog time out.
17	X			Check/replace sensor/ extension cable.	SpO2 front end reports that sensor appears defective.
18		X		Replace SpO2 board.	SpO2 front end reports internal register appears modified from expected value.
19	X			Check/replace sensor/ extension cable.	SpO2 front end reports signal out-of-range.
48		X		Replace SpO2 board.	SpO2 front end reports spurious interrupt.
49		X		Replace SpO2 board.	SpO2 front end reports internal buffer overflow.
50		X		Replace SpO2 board.	SpO2 front end reports intermittent error.
51		X		Replace SpO2 board.	SpO2 front end reports digital communication error.
53		X		Replace SpO2 board.	SpO2 front end data not received.
256		X		Replace SpO2 board.	SpO2 back end reports beginning of packet missing.
257		X		Replace SpO2 board.	SpO2 back end reports packet start ID (SID) missing.
258		X		Replace SpO2 board.	SpO2 back end reports packet length error.
259		X		Replace SpO2 board.	SpO2 back end reports message length error.
260		X		Replace SpO2 board.	SpO2 back end reports packet contains unsupported key.
261		X		Replace SpO2 board.	SpO2 back end reports packet CRC error.

Table 4: Error Codes (Continued)

Error Code	Scope of Action			Action	Explanation
	Clinician	Repair	Return		
262		X		Replace SpO2 board.	SpO2 back end reports end of packet missing.
263		X		Replace SpO2 board.	SpO2 back end reports packet contains unidentified key.
264		X		Replace SpO2 board.	SpO2 back end reports corrupted variable.
265		X		Replace SpO2 board.	SpO2 back end reports memory overflow.
266		X		Replace SpO2 board.	SpO2 back end reports bad pointer.
267		X		Replace SpO2 board.	SpO2 back end reports parameter value out-of-range.
268		X		Replace SpO2 board.	SpO2 back end reports reset detected.
269		X		Replace SpO2 board.	SpO2 back end reports unexpected value.
270		X		Replace SpO2 board.	SpO2 back end reports time-out.
271		X		Replace SpO2 board.	SpO2 back end reports not ready/not initialized.
272		X		Replace SpO2 board.	SpO2 back end reports double fault.
273	1, 2	3		1 — Restart the NPB-40. 2 — Set the time and date. 3 — Replace UI board.	SpO2 back end reports date out-of-range error.
274			X	Return NPB-40 for reprogramming.	SpO2 back end reports incompatible software version.
275	X			Check/replace sensor/ extension cable.	SpO2 back end reports incorrect registration number.
276	X			Replace with OxiMax sensor/ extension cable.	SpO2 back end reports sensor read failure.
277	X			Check/replace sensor/ extension cable.	SpO2 back end reports sensor signature verification fails.
280	X			Check/replace sensor/ extension cable.	SpO2 back end reports does not support feature required by sensor.
281	X			Check/replace sensor/ extension cable.	SpO2 back end reports overflow/ underflow.
282	X			Check/replace sensor/ extension cable.	SpO2 back end reports sensor activation failure.
512		X		Replace UI board.	Communication failure with real time clock.
513		X		Replace UI board.	Real time clock oscillator control problem.
514		X		Replace UI board.	Real time clock failed timing test.
515		X		Replace UI board.	LCD failed feedback test.
516		X		Replace UI board.	LCD failed feedback test.
518			X	Return NPB-40 for repair.	Various system faults.
519			X	Return NPB-40 for repair.	Unrecoverable software error.

Table 4: Error Codes (Continued)

Error Code	Scope of Action			Action	Explanation
	Clinician	Repair	Return		
520		X		Replace UI board.	Unrecoverable error verify real time clock.
521	X			Replace batteries.	Battery power is critically low.
522	X			Replace batteries.	System power levels unacceptable for continued operation.
523	1, 2	3		1 — Restart the NPB-40. 2 — Set the time and date. 3 — Replace UI board.	NVRAM failed consistency check.
524		X		Replace UI board.	NVRAM failed read-after-write verification.
525	X	X		Restart, replace UI board.	Time base discrepancy writing error entry.
526		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Fatal error for SpO2 communication.
527		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Communication failure with SpO2 board.
528		1	2	1 — Replace UI board 2 — Return NPB-40 for repair.	Fatal error creating parser.
529		1	2	1 — Replace UI board 2 — Return NPB-40 for repair.	Fatal error creating parser.
530		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
531		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
532		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
533		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
534		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
535		1, 2		1 — Replace SpO2 board. 2 — Replace UI board.	Unrecoverable error with SpO2 communication.
536		X		Replace UI board.	Flash memory failed CRC check.
537		X		Replace UI board.	Fatal system error.
538	X			Set the NPB-40 time and date.	Real time clock value bad.
539	1	2		1 — Restart the NPB-40. 2 — Replace membrane switch pad.	Erroneous key press detected at start.
540		X		Replace UI board.	Fatal system error reading memory.
541			X	Return NPB-40 for repair.	Fatal software error.
542		1	2	1 — Replace UI board. 2 — Return NPB-40 for repair.	RAM corruption detected during background check.

Table 4: Error Codes (Continued)

Error Code	Scope of Action			Action	Explanation
	Clinician	Repair	Return		
543	X			Set time and date.	Invalid time. Cannot snapshot.
544		X		Replace UI board.	Invalid register value.
999		X		Replace UI board.	Watchdog protection activated.

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Disassembly Guide

Introduction

The NPB-40 can be disassembled into to all major component parts, including:

- Front case with front panel keypad
- Rear bottom
- Display PCB
- CPU PCB
- Battery compartment door

Note: Some spare parts have a business reply card attached. Please fill out and return the business reply card.

Caution: Observe ESD (electrostatic discharge) precautions when disassembling and reassembling the NPB-40 and when handling any components of the NPB-40.

Tools Required

The tools required to disassemble and reassemble the NPB-40 are:

- Number one (medium) Phillips screwdriver
- Torque driver, four inch/pounds (10 cm/kg)

Replacement Level Supported

The replacement level supported for the NPB-40 is to the printed circuit board (PCB) and major subassembly level. When the problem has been isolated to a suspected PCB, follow the procedures in *Disassembly Guide* on page 43, to replace the PCB with a known good PCB. Check to see if the trouble symptom disappears and that the NPB-40 passes all performance tests. If the trouble symptom persists, swap back the replacement PCB with the suspected malfunctioning PCB (the original PCB that was installed when you started troubleshooting) and continue troubleshooting.

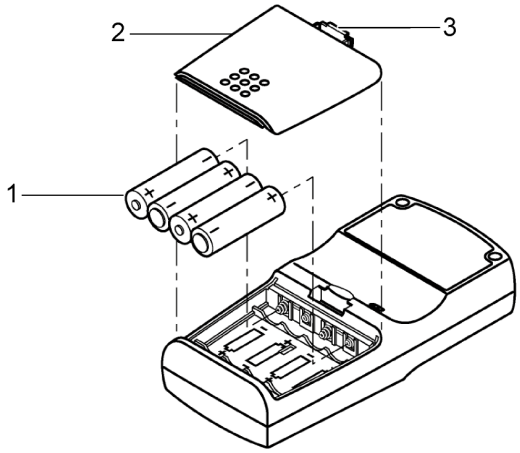
Prior to Disassembly

The NPB-40 the batteries must be removed prior to disassembly. Perform the following procedure to remove the batteries.

1. Press the Power button to turn the NPB-40 off.

2. Remove the battery cover: pull the battery cover latch downward toward the bottom of the NPB-40 case and lift the battery cover. See Figure 4, item 1.

3. Remove the batteries.



1 — Batteries
2 — Battery cover
3 — Battery cover latch

Figure 4: Installing Batteries

Separating the Front and Back Cases

Do the following procedure to separate the NPB-40 front and back cases.

1. Do the procedure in paragraph *Prior to Disassembly* on page 43.

2. Remove the four screws holding the NPB-40 front and rear cases together. See Figure 5, items 1 through 4.

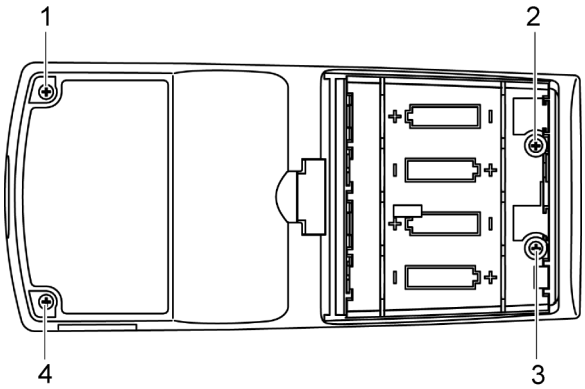
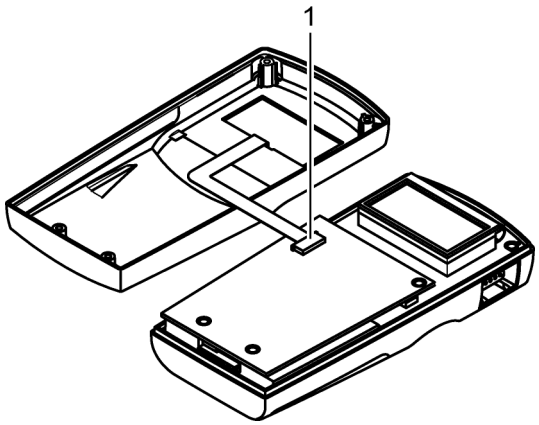


Figure 5: NPB-40 Case Screws

Caution: A cable runs between the NPB-40 front and rear case assemblies. Use care when separating the cases. Do not apply stress to the cable.

3. Separate the NPB-40 front and rear case assemblies. See Figure 6.

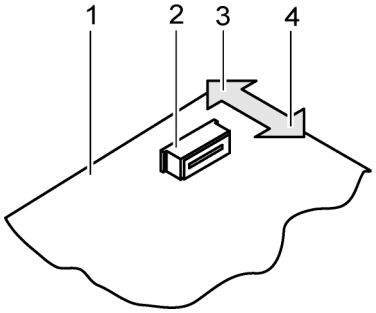


1 — Connector J3

Figure 6: Cases Separated

Caution: Failure to unlock connector J3 on the CPU PCB before attempting to remove the front case flex circuit could damage the flex circuit.

4. Unlock connector J3 on the CPU PCB. See Figure 6 and Figure 7.



1 — CPU PCB
2 — J3 lock
3 — Lock direction
4 — Unlock direction

Figure 7: CPU PCB Connector J3 Lock

5. Disconnect the ribbon cable from CPU PCB connector J3.

CPU PCB or Display PCB Replacement

Do the following procedure to replace the CPU PCB or the display PCB.

1. Do the procedure in paragraph *Prior to Disassembly* on page 43.

2. Do the procedure in paragraph *Separating the Front and Back Cases* on page 44.

Caution: The battery connectors (spring assemblies) at the bottom of the CPU PCB are held in slots in the battery compartment. Observe how these connectors are engaged in these slots when you remove the CPU PCB and display PCB and ensure that the battery connectors are inserted back into these slots when you reassemble the NPB-40.

3. Pull the CPU PCB and display PCB to the left and lift the CPU PCB and display PCB from the case. See Figure 8.

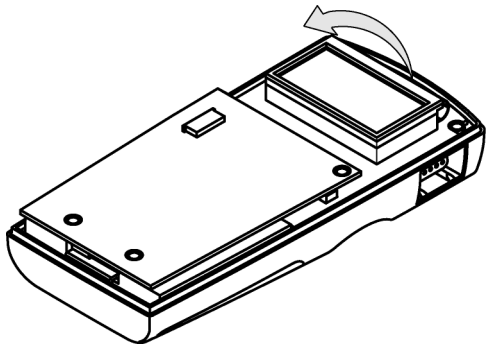
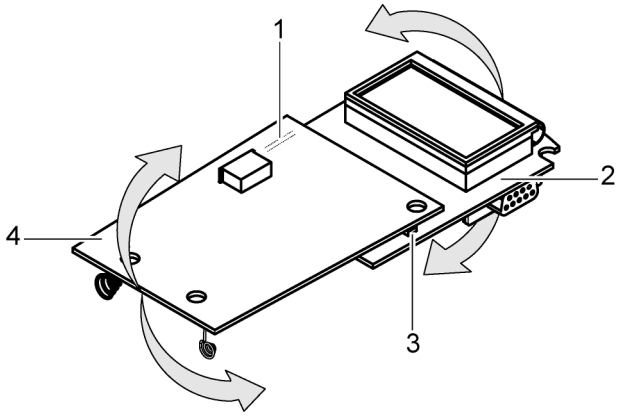


Figure 8: Display PCB and CPU PCB Removal

Caution: Do not force the display PCB and CPU PCB apart. This may damage the boards. Gently work the boards apart.

To separate the Display PCB and the CPU PCB, grasp the display PCB in one hand and the CPU PCB in the other. Rotate the ends of the two PCBs as shown in Figure 9 until the two PCBs separate at the connectors J1 and J2.

4. Separate the display PCB from the CPU PCB. See Figure 9.

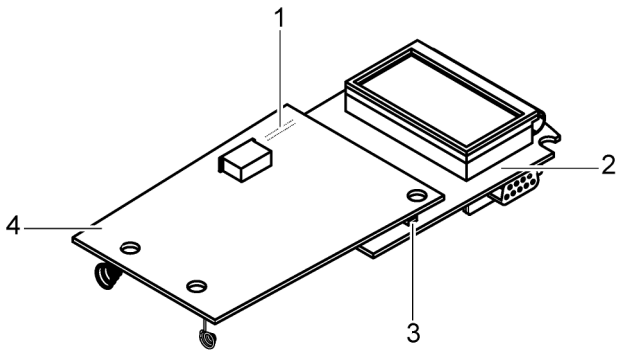


1 — J1
2 — Display PCB
3 — J2
4 — CPU PCB

Figure 9: Separating the Display PCB and CPU PCB

5. Place the defective PCB to the side.

6. Align the new PCB (J1 and J2) and the removed good PCB (J1 and J2) and gently press them together. See Figure 10.



1 — J1
2 — Display PCB
3 — J2
4 — CPU PCB

Figure 10: Connecting PCBs

7. Install the display PCB and CPU PCB into the NPB-40 case. Ensure that the battery springs slip into place. See Figure 11.

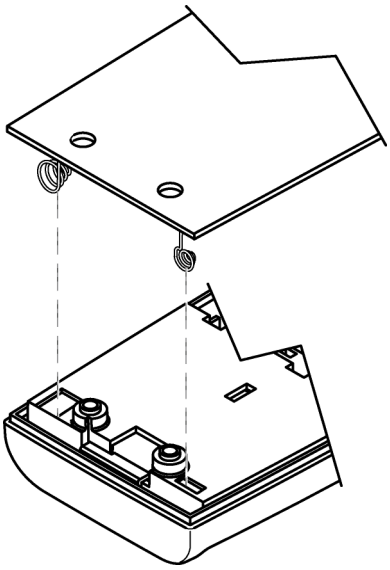


Figure 11: Battery Spring Alignment

Note: The longer screws install at the top of the case. See Figure 12, items 1 and 4.

8. Align the front and rear cases. See Figure 12.

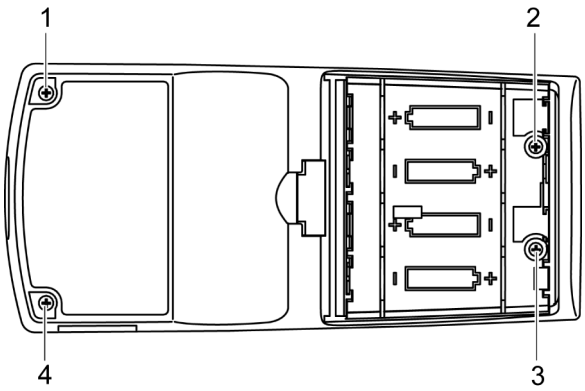
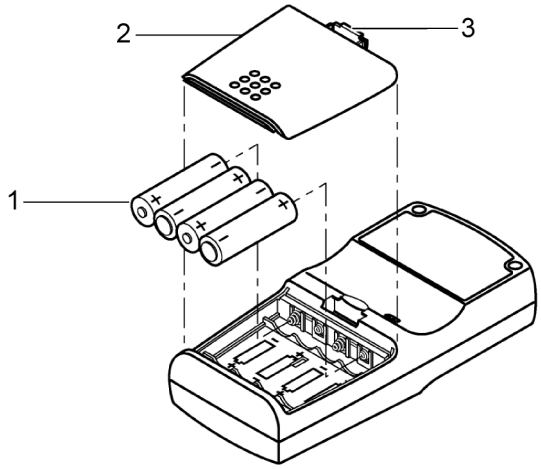


Figure 12: Installing The Case Screws

9. Install the four screws (Figure 12, items 1 through 4).

10. Install the batteries and battery cover. See Figure 13.



1 — Batteries
2 — Battery cover
3 — Battery cover latch

Figure 13: Battery Installation

11. Perform the performance verification tests before placing the NPB-40 into service. See *Pulse Oximetry Functional Tests* on page 24.

Front Case Assembly Replacement

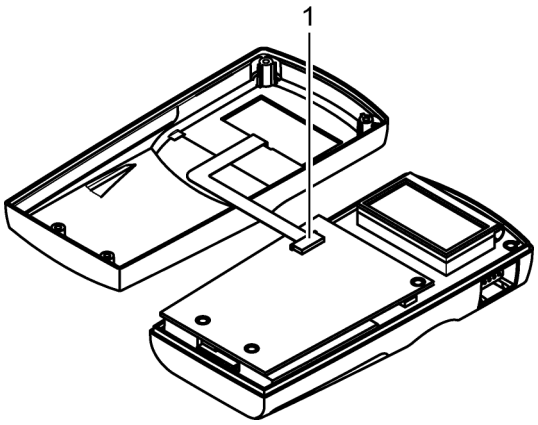
The front case assembly contains the keypad. Perform the following procedure to replace the front case assembly.

1. Remove the batteries from the NPB-40. See *Prior to Disassembly* on page 43.

2. Separate the front and rear case assemblies. See *Separating the Front and Back Cases* on page 44.

3. Dispose of the front case assembly in accordance with local regulations.

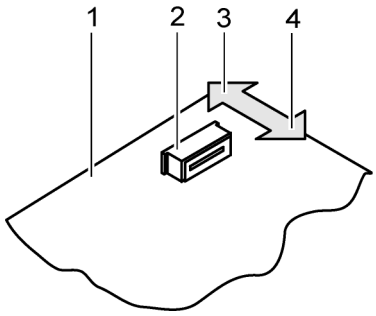
4. Connect the new front case assembly ribbon cable to the CPU PCB connector J3. See Figure 14.



1 — J3

Figure 14: Front Case Ribbon Cable Connection

5. Lock the ribbon cable connector. See Figure 15.



1 — CPU PCB

2 — J3 lock

3 — Lock direction

4 — Unlock direction

Figure 15: Locking CPU PCB Connection to J3

6. Place the front and rear cases together and install the four screws. See Figure 16, items 1 through 4.

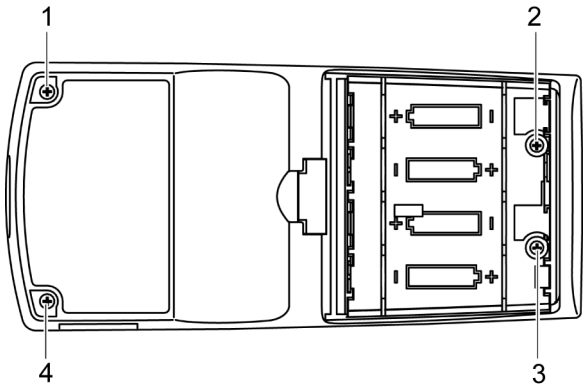
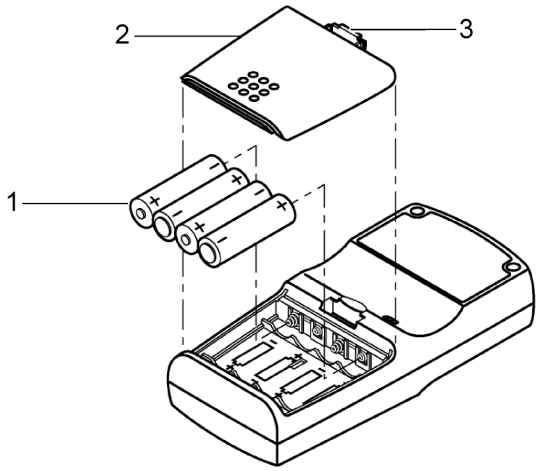


Figure 16: Installing The Case Screws

7. Install the batteries and battery cover as shown in Figure 17.



1 — Batteries
2 — Battery cover
3 — Battery cover latch

Figure 17: Battery Installation

8. Perform the performance verification tests before placing the NPB-40 into service. See *Pulse Oximetry Functional Tests* on page 24.

Rear Case Assembly Replacement

Perform the following procedure to replace the rear case assembly.

1. Remove the batteries from the NPB-40. See *Prior to Disassembly* on page 43.

2. Separate the front and rear case assemblies. See *Separating the Front and Back Cases* on page 44.

Caution: The battery connectors (spring assemblies) at the bottom of the CPU PCB are held in slots in the battery compartment. Observe how these connectors are engaged in these slots when you remove the CPU PCB and display PCB and ensure that the battery connectors are inserted back in these slots when you reassemble the NPB-40.

3. Lift the CPU PCB and display PCB from the case. See Figure 18.

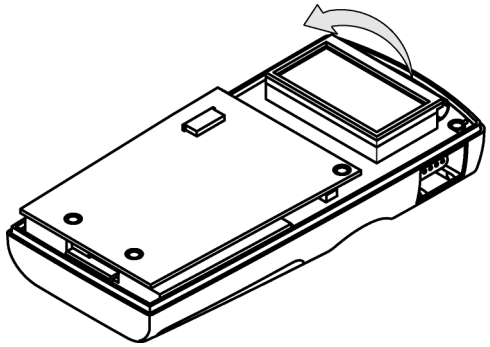


Figure 18: Display PCB and CPU PCB Removal

4. Discard the rear case assembly in accordance with local regulations.

5. Install the display PCB and CPU PCB into the NPB-40 case. Ensure that the battery springs slip into place. See Figure 19.

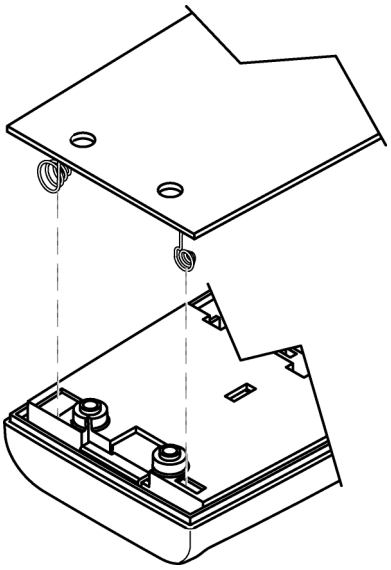


Figure 19: Battery Spring Alignment

Note: The longer screws install at the top of the case. See Figure 20, items 1 and 4.

6. Place the front and rear cases together and install the four screws. See Figure 20.

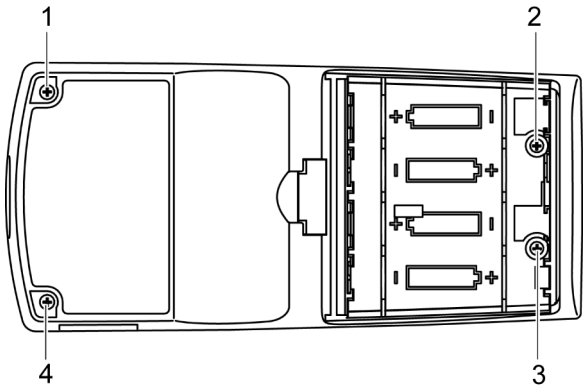


Figure 20: Installing The Case Screws

7. Install the batteries and battery cover. See Figure 21.

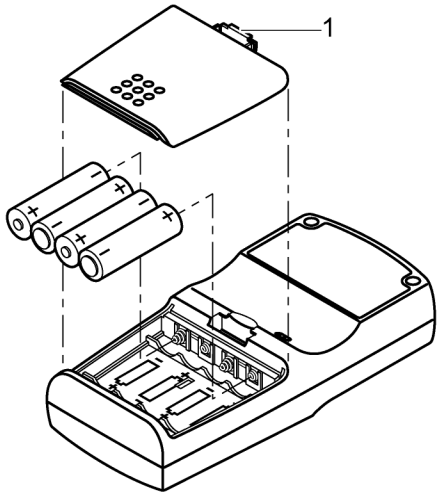


Figure 21: Battery Installation

8. Perform the performance verification tests before placing the NPB-40 into service. See *Pulse Oximetry Functional Tests* on page 24.

Battery Compartment Door Replacement

Perform the following procedure to replace the battery compartment door.

1. Press battery door latch (Figure 22, item 1) and lift the battery door from the NPB-40 rear case.

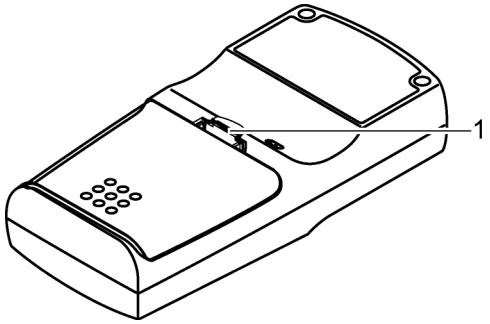


Figure 22: Battery Compartment Door Latch

2. Insert new battery compartment door in case and close until the battery door latch snaps in place.

Spare Parts

Introduction

The latest version of this manual is available on the Internet at:

http://www.mallinckrodt.com/respiratory/resp/Serv_Supp/ProductManuals.html

Spare parts are shown in Table 5. Item numbers correspond to the callout numbers in Figure 23.

Obtaining Replacement Parts

Nellcor's Technical Services provides technical assistance information and replacement parts. To obtain replacement parts, contact Nellcor's Technical Services or your local Nellcor representative. Refer to parts by the part names and part numbers.

Spare parts and accessories for the NPB-40 are listed on the Internet at:

http://mallinckrodt.com/respiratory/resp/Serv_Supp/Apartweb/main/PartAcceMenu.html

Parts List and Accessories

Table 5: Parts and Accessories List

Figure 23 Reference	Description
Spare Parts	
5	Battery cover
--	Battery, alkaline, 1.5V, type AA
4	Bottom enclosure
--	Buttons, set of 7, membrane switch panel
--	LCD assembly
--	Product data label
--	Quick guide label
--	Screw, PH, 4 X /16 inch
--	Screw, PH, 4 X 3/16 inch
3	SpO_2 PCB
1	Top enclosure
2	User interface PCB
Accessories	
--	Battery, alkaline, type AA, Duracel Gold Top
--	Boot, protective, silicone, yellow
--	Case, carry, fabric, black with shoulder strap
--	CD, operator and service manuals

Table 5: Parts and Accessories List (Continued)

Figure 23 Reference	Description
--	DEC-4 sensor extension cable
--	Home Use Guide, English
--	Jacket, water resistant, clear, plastic
--	Operator’s manual, Chinese
--	Operator’s manual, Czechoslovakian
--	Operator’s manual, Danish
--	Operator’s manual, Dutch
--	Operator’s manual, English
--	Operator’s manual, Finnish
--	Operator’s manual, French
--	Operator’s manual, German
--	Operator’s manual, Greek
--	Operator’s manual, Hungarian
--	Operator’s manual, Italian
--	Operator’s manual, Japanese
--	Operator’s manual, Norwegian
--	Operator’s manual, Polish
--	Operator’s manual, Portuguese
--	Operator’s manual, Russian
--	Operator’s manual, Spanish
--	Operator’s manual, Swedish
--	Operator’s manual, Turkish
--	Paper, for Citizen printer, roll
--	Printer, Citizen model PD-22T
--	Service manual, English
--	Strap, protective boot
--	SRC-MAX tester, pulse oximeter

Figure 23 shows the NPB-40 expanded view with numbers relating to the spare parts list.

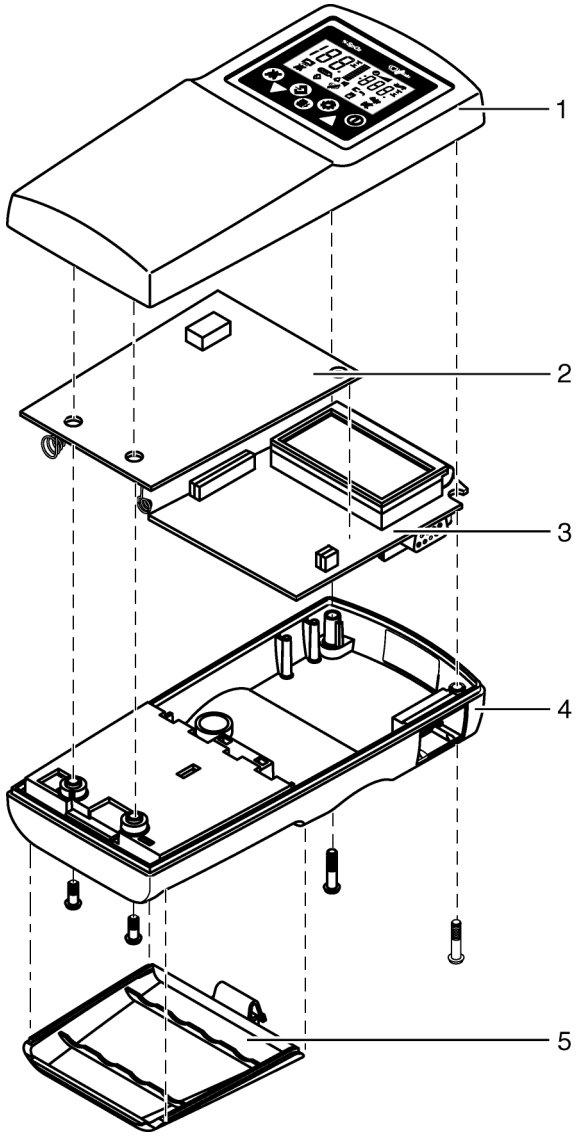


Figure 23: Exploded View

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Packing for Shipment

Introduction

To ship the NPB-40, follow the instructions in this section.

Returning the NPB-40

Contact Nellcor's Technical Services Department or your local Nellcor representative for shipping instructions, including a Returned Goods Authorization (RGA) number. Unless otherwise instructed by Nellcor's Technical Services Department, it is not necessary to return the *OxiMax* sensor or other accessory items with the NPB-40. Pack the NPB-40 in its original shipping carton. If the original carton is not available, use a suitable carton with appropriate packing material to protect it during shipping.

Return the NPB-40 by any shipping method that provides proof of delivery.

Pack the NPB-40 carefully. Failure to follow the instructions in this section may result in loss or damage not covered by any applicable Nellcor warranty. If the original shipping carton is not available, use another suitable carton; North American customers may call Nellcor's Technical Services Department to obtain a shipping carton.

Repacking in Original Carton

If available, use the original carton and packing materials. See Figure 24. Pack the NPB-40 as follows:

1. Place the NPB-40 original packaging.

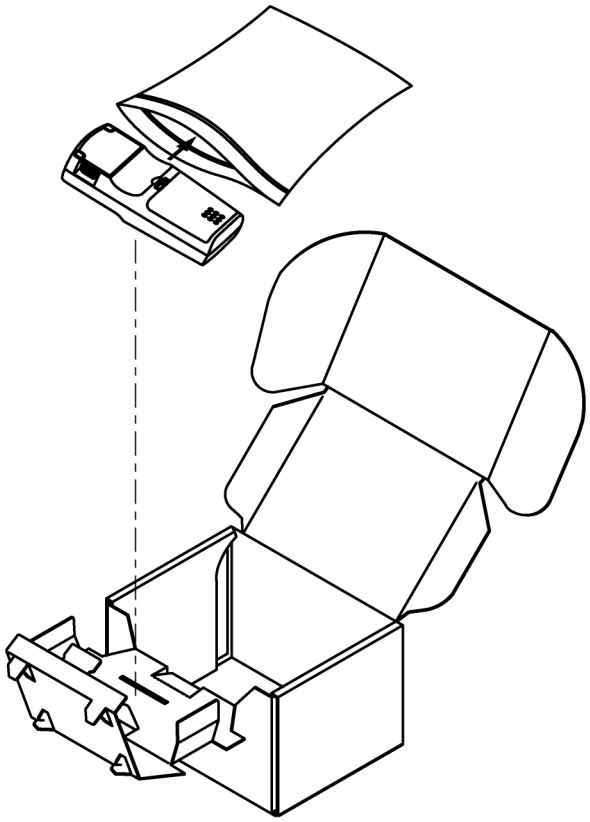

Figure 24: Packing

2. Place in shipping carton and seal carton with packing tape.

3. Label carton with shipping address, return address, and RGA number.

Packing in a Different Carton

If the original carton is not available, use the following procedure to pack the NPB-40:

1. Place the NPB-40 in a plastic bag.

2. Locate a corrugated cardboard shipping carton with a bursting strength of at least 200 pounds per square inch (psi).

3. Fill the bottom of the carton with at least two inches of packing material.

4. Place the bagged unit on the layer of packing material and fill the box completely with packing material.

5. Seal the carton with packing tape.

6. Label the carton with the shipping address, return address, and RGA number.

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Performance

Measurement Range

SpO_2	1% to 100%
Pulse Rate	0, 20 beats per minute (bpm) to 300 bpm
Perfusion Range	0.03% to 20%

Accuracy and Motion Tolerance

Saturation	
Without Motion [1]	70 to 100% ±2 digits
With Motion [2]	70 to 100% ±3 digits
Low Perfusion[3]	70 to 100% ±2 digits
Pulse Rate	
Without Motion [1, 2, 3]	20 to 250 bpm ±3 digits
With Motion [2]	normal physiologic range (55 - 125 bpm) ±5 digits
Low Perfusion [3]	20 to 250 bpm ±3 digits

[1] Saturation accuracy will vary by sensor type. Refer to the Sensor Accuracy Grid. The Sensor Accuracy Grid is shipped with the NPB-40. The latest version of the Sensor Accuracy Grid is available on the Internet at:

http://www.mallinckrodt.com/respiratory/resp/Serv_Supp/ProductManuals.html

[2] Applicability: *OxiMax* MAX-A, MAX-FAST, DS-100A, D-YSE, SC-NEO, and OxiCliq A sensors.

[3] Specification applies to NPB-40 performance.

Display Update Interval

100 millisecond

Audible Indicators

Audible Indicator	Parameter	Value
Alarm Volume Setting	Volume level	Adjustable, 40 to 52 dB(A), at one meter
	Pitch (±30 Hz)	752 Hz
	On pulse width (±20 msec)	500 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	1
Beep Volume setting	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	1500 Hz
	On pulse width (±20 msec)	500 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	2
POST Pass	Volume level	Fixed at 45 dB(A), at one meter
	Pitch (±30 Hz)	600 Hz
	On pulse width (±20 msec)	1000 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	3
Invalid Key Press	Volume level	Fixed at 45 dB(A), at one meter
	Pitch (±30 Hz)	200 Hz
	On pulse width (±20 msec)	50 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	4

Audible Indicators (Continued)

Audible Indicator	Parameter	Value
Confirmation	Volume level	Fixed at 45 dB(A), at one meter
	Pitch (±30 Hz)	700 Hz
	On pulse width (±20 msec)	130 msec
	Off Interval (±20 msec)	130 msec
	Number of pulses in burst	3
	Repetition Pause (±2 sec.)	N/A
	Priority	5
Valid Key Press	Volume level	Fixed at 45 dB(A), at one meter
	Pitch (±30 Hz)	800 Hz
	On pulse width (±20 msec)	10 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	6
Pulse Beep	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	1500 Hz
	On pulse width (±20 msec)	50 msec
	Off Interval (±20 msec)	10 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	N/A
	Priority	7
Alarm Silence Reminder	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	500 Hz
	On pulse width (±20 msec)	130 msec
	Off Interval (±20 msec)	130 msec
	Number of pulses in burst	3
	Repetition Pause (±2 sec.)	179.27 sec.
	Priority	8

Audible Indicators (Continued)

Audible Indicator	Parameter	Value
High Priority Alarm	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	1200 Hz
	On pulse width (±20 msec)	250 msec
	Off Interval (±20 msec)	80 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	0 sec.
	Priority	9
Medium Priority Alarm	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	752 Hz
	On pulse width (±20 msec)	400 msec
	Off Interval (±20 msec)	300 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	0 sec.
	Priority	10
Low priority Alarm	Volume level	Adjustable, 42 to 52 dB(A), at one meter
	Pitch (±30 Hz)	500 Hz
	On pulse width (±20 msec)	400 msec
	Off Interval (±20 msec)	3200 msec
	Number of pulses in burst	1
	Repetition Pause (±2 sec.)	0 sec.
	Priority	11

Electrical

Batteries

The batteries provide at least 15 hours of battery life with no alarms, no printing, and with backlight on while using a pulse simulator set for 200 bpm, high light and low modulation.	
Type	4 AA alkaline
Voltage	1.5 Volts DC (each)

OxiMax Sensors

Wavelength	The wavelength range of the light emitted are near 660 nm and 890 nm.

OxiMax Sensor Power Dissipation

Sensor	Dissipation
OxiMax MAX-N	52.5 mW
OxiMax MAX-I	52.5 mW
OxiMax MAX-P	52.5 mW
OxiMax MAX-A	52.5 mW
OxiMax MAX-AL	52.5 mW
OxiMax MAX-R	52.5 mW
OxiMax Durasensor DS-100A	52.5 mW
OxiMax OxiCliq® P	52.5 mW
OxiMax OxiCliq N	52.5 mW
OxiMax OxiCliq I	52.5 mW
OxiMax OxiCliq A	52.5 mW
OxiMax Dura-Y® D-YS	52.5 mW
OxiMax MAX-FAST	52.5 mW
OxiMax Softcare SC-PR	52.5 mW
OxiMax Softcare SC-NEO	52.5 mW
OxiMax Softcare SC-A	52.5 mW
OxiMax Oxiband OXI-A/N	52.5 mW

Environmental Conditions

Operation

Temperature	5 ºC to 40 ºC (41 ºF to 104 ºF)
Altitude	-390 m to 3,012 m (-1,254 ft. to 9,882 ft.)
Atmospheric Pressure	70 kPa to 106 kPa (20.6 in. Hg to 31.3 in. Hg)
Relative Humidity	15% to 95% non-condensing

Transport and Storage (not in shipping container)

Temperature	-20 ºC to 60 ºC (-4 ºF to 140 ºF)
Altitude	-390 m to 5,574 m (-1,280 ft. to 18,288 ft.)
Atmospheric Pressure	50 kPa to 106 kPa (14.7 in. Hg to 31.3 in. Hg)
Relative Humidity	15% to 95% non-condensing

Transport and Storage (in shipping container)

Temperature	-20 ºC to 70 ºC (-4 ºF to 158 ºF)
Altitude	-390 m to 5,574 m (-1,280 ft. to 18,288 ft.)
Atmospheric Pressure	50 kPa to 106 kPa (14.7 in. Hg to 31.3 in. Hg)
Relative Humidity	15% to 95% non-condensing

Physical Characteristics

Weight	0.62 lbs. (0.28 kg)
Dimensions	2.875 in. x 6.25 in. x 1.375 in. (7.3 cm x 15.9 cm x 3.5 cm)

Compliance

Item	Compliant With
Equipment classification	Safety Standards: EN 60601-1: 1990 (A1 + A2), EN 60601-1-2: 2001, UL 60601-1, CAN/CSA C22.2 No. 601.1
Type of protection	Internally powered equipment (on battery power)
Degree of protection	Type BF - Applied part
Mode of operation	Continuous
Front panel and case labeling	IEC 60878, EN 980, ISO 7000, EN 60417-1, EN 60417-2
Button spacing	ISO 7250
Year of manufacture symbol	EN 980
Operation during physical shock	IEC 60068-2-27 at 100 g
Alarm requirements	EN 60601-1-8
Pulse oximeters	EN 865
Operation during vibration	IEC 60068-2-6 and IEC 60068-2-34
Radiated and conducted emissions	EN 55011, Group 1, Class B

Manufacturer's Declaration

WARNING: The use of accessories, sensors, and cables other than those specified may result in increased emission and/or create invalid readings of the NPB-40.

The NPB-40 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or user of the NPB-40 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the NPB-40 as recommended below, according to the maximum output of the communications equipment.

Recommended Separation Distances between Portable and Mobile RF Communications Equipment and the NPB-40 (IEC 60601-1-2)

Frequency of Transmitter	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
Equation	$d = \left[\frac{3.5}{V_1}\right]\sqrt{P}$	$d = \left[\frac{3.5}{E_1}\right]\sqrt{P}$	$d = \left[\frac{7}{V_1}\right]\sqrt{P}$
Rated Maximum Output Power of Transmitter in Watts	Separation Distance in Meters	Separation Distance in Meters	Separation Distance in Meters
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the separation distance can be estimated using the equation in the corresponding column, where P is the maximum output [power rating of the transmitter in watts (W)] according to the transmitter manufacturer.

Note: At 80 MHz to 800 MHz, the separation distance for the higher frequency range applies.

Note: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

Table 6: Electronic Emissions

The NPB-40 is intended for use in the electromagnetic environment specified below. The customer or user of the NPB-40 should assure that it is used in such an environment.

Emission Test	**Compliance**	**Electromagnetic Environment - Guidance**
RF emissions CISPR 11	Group 1	The NPB-40 uses RF energy only for its internal function. Therefore, the RF emissions are very low and not likely to cause interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The NPB-40 is suitable for use in establishments, including diagnostic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

Table 7: Electromagnetic Immunity

The NPB-40 is intended for use in the electromagnetic environment specified below. The customer or user of the NPB-40 should assure that it is used in such an environment.

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment Guidance
Electrostatic Discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	Complies	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV power supply lines ± 1 kV for input/output lines	Complies	Main power should be that of a typical commercial or hospital environment.
Power Frequency (50/60 Hz) magnetic field	3 A/m	Complies	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	Portable and mobile RF communications equipment should be used no closer to any part of the NPB-40, including the cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 Vrms	
Recommended Separation Distance $d = \left[\frac{3.5}{V_1}\right]\sqrt{P}$			where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).

Table 7: Electromagnetic Immunity (Continued)

The NPB-40 is intended for use in the electromagnetic environment specified below. The customer or user of the NPB-40 should assure that it is used in such an environment.

$d = \left[\frac{3.5}{E_1}\right]\sqrt{P}$	80 MHz to 800 MHz	Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a] , should be less than the compliance level in each frequency range.[b]
$d = \left[\frac{7}{V_1}\right]\sqrt{P}$	800 MHz to 2.5 GHz	

Interference may occur in the vicinity of equipment marked with this symbol.

Note 1: At 80 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

[a] Field strength from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in which the NPB-40 is used exceeds the applicable RF compliance level above, the NPB-40 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the NPB-40.

[b] Over the frequency range 150 kHz to 80 MHz, field strength should be less than [V_1 } V/m.

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Technical Discussion

Oximetry Overview

The NPB-40 uses pulse oximetry to measure functional oxygen saturation in the blood. Pulse oximetry works by applying an *OxiMax* sensor to a pulsating arteriolar vascular bed, such as a finger or toe. The *OxiMax* sensor contains a dual light source and a photo detector.

Bone, tissue, pigmentation, and venous vessels normally absorb a constant amount of light over time. The arteriolar bed normally pulsates and absorbs variable amounts of light during the pulsations. The ratio of light absorbed is translated into a measurement of functional oxygen saturation (SpO_2).

Because a measurement of SpO_2 is dependent upon light from the *OxiMax* sensor, excessive ambient light can interfere with this measurement.

Specific information about ambient conditions, *OxiMax* sensor application, and patient conditions is contained throughout this manual.

Pulse oximetry is based on two principles: that oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (i.e., spectrophotometry), and that the volume of arterial blood in tissue (and hence, light absorption by that blood) changes during the pulse (i.e., plethysmography). A pulse oximeter determines SpO_2 by passing red and infrared light into an arteriolar bed and measuring changes in light absorption during the pulsatile cycle. Red and infrared low-voltage light-emitting diodes (LED) in the oximetry *OxiMax* sensor serve as light sources; a photo diode serves as the photo detector.

Because oxyhemoglobin and deoxyhemoglobin differ in light absorption, the amount of red and infrared light absorbed by blood is related to hemoglobin oxygen saturation. To identify the oxygen saturation of arterial hemoglobin, the pulse oximeter uses the pulsatile nature of arterial flow. During systole, a new pulse of arterial blood enters the vascular bed, and blood volume and light absorption increase. During diastole, blood volume and light absorption reach their lowest point. The pulse oximeter bases its SpO_2 measurements on the difference between maximum and minimum absorption (i.e., measurements at systole and diastole). By doing so, it focuses on light absorption by pulsatile arterial blood, eliminating the effects of nonpulsatile absorbers such as tissue, bone, and venous blood.

Functional versus Fractional Saturation

This pulse oximeter measures functional saturation -- oxygenated hemoglobin expressed as a percentage of the hemoglobin that can transport oxygen. It does not detect significant amounts of dysfunctional hemoglobin, such as carboxyhemoglobin or methemoglobin. In contrast, hemoximeters such as the IL482 report fractional saturation -- oxygenated hemoglobin expressed as a

percentage of all measured hemoglobin, including measured dysfunctional hemoglobins. To compare functional saturation measurements to those from an instrument that measures fractional saturation, fractional measurements must be converted as follows:

$$\text{functional saturation} = \frac{\text{fractional saturation}}{100 - (\%\,\text{carboxyhemoglobin} + \%\,\text{methemoglobin})} \times 100$$

Measured versus Calculated Saturation

When saturation is calculated from a blood gas partial pressure of oxygen (PO_2), the calculated value may differ from the SpO_2 measurement of a pulse oximeter. This usually occurs because the calculated saturation was not appropriately corrected for the effects of variables that shift the relationship between PO_2 and pH, temperature, the partial pressure of carbon dioxide (PCO_2), 2,3-DPG, and fetal hemoglobin. See Figure 25.

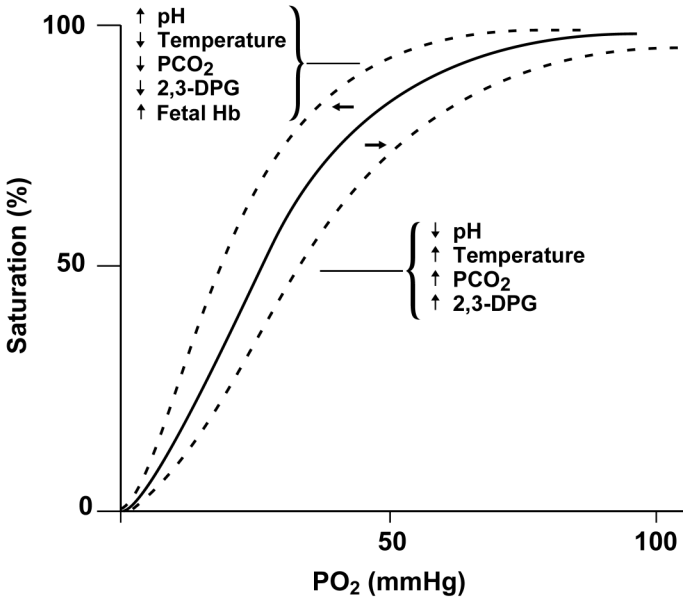


Figure 25: Oxyhemoglobin Dissociation Curve

SatSeconds Alarm Management

The NPB-40 utilizes Nellcor *SatSeconds* alarm management technique. *SatSeconds* is a function of the software within the NPB-40. With the *SatSeconds* technique, upper and lower alarm limits are set in the same way as traditional alarm management. The clinician also sets a *SatSeconds* limit that allows monitoring of $\%SpO_2$ below the selected lower alarm limit for a period of time before an audible alarm sounds. Refer to the NPB-40 Operator's manual for managing *SatSeconds*.

Reads Through Motion

The NPB-40 takes advantage of increased micro processing power with advanced mathematical algorithms. *OxiMax* advanced signal processing allows the NPB-40 to read through challenging motion conditions to deliver accurate saturation and pulse rate values. For a definition of motion, as applicable to the NPB-40, contact Nellcor's Technical Services Department.

OxiMax Technology

The NPB-40 is designed to use Nellcor brand *OxiMax* sensors containing *OxiMax* technology. These *OxiMax* sensors can be identified by the deep blue color of their plug. All *OxiMax*-compatible sensors contain a memory chip carrying information about the *OxiMax* sensor which the NPB-40 needs for correct operation, including the *OxiMax* sensor's calibration data, model type, troubleshooting codes, and error detection data. This unique oximetry architecture enables several new features with the NPB-40.

When an *OxiMax*-compatible sensor is connected to the NPB-40, the NPB-40 first reads the information in the *OxiMax* sensor memory chip, checks it to make sure that there are no errors, and then loads the data to begin monitoring. As the NPB-40 reads the information, it flashes the Data In-Sensor icon. This process takes a couple of seconds. Once the reading process is complete the NPB-40 begins monitoring.

Pulse Oximeters containing *OxiMax* technology, including the NPB-40, use calibration data contained in the *OxiMax* sensor in calculating the patient's SpO_2.

Block Diagram Theory

This section provides an explanation of NPB-40 block diagram theory of operation. Schematic diagrams and are provided at the end of this section.

The NPB-40 consists of two printed circuit boards (PCB), the user interface PCB and the SpO2 PCB. The relationship between these two components and their interconnections is shown in the NPB-40 block diagram. See Figure 26.

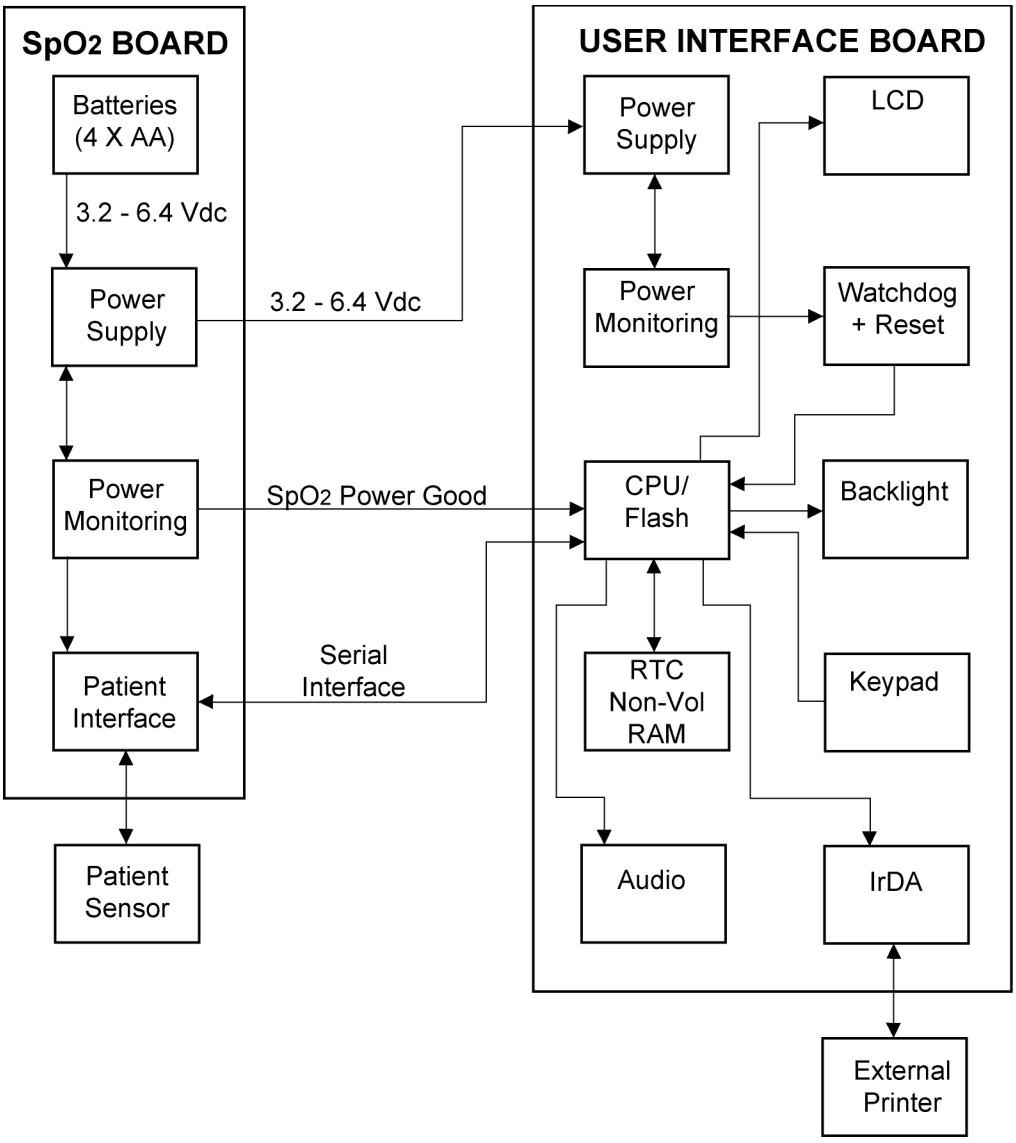


Figure 26: Block Diagram

SpO_2 Printed Circuit Board

The SpO2 PCB provides patient interface and NPB-40 operating power.

Patient Interface

The patient interface receives signals from the *OxiMax* patient sensor. These signal are converted and supplied to the user interface PCB central processing unit (CPU). The patient interface receives control signals from the CPU. These control signals are used to control the light emitting diodes in the *OxiMax* patient sensor.

Power Supply

The power supply provides operating voltages to the SpO_2 PCB and the user interface PCB. These voltages are supplied to the:

- SpO_2 PCB power monitoring function
- SpO_2 PCB circuits
- user interface PCB power supply
- user interface PCB CPU
- user interface PCB audio circuits

Power Monitoring

The SpO_2 power monitoring function monitors and controls the outputs of the SpO_2 power supply. The SpO_2 power monitoring function provides the user interface CPU and SpO_2 patient interface with status information on the power supply output signals.

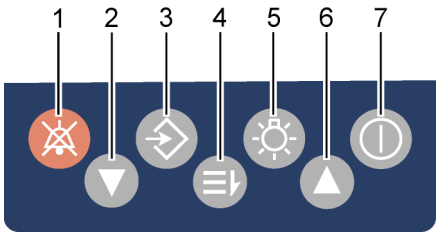
User Interface Printed Circuit Board

The user interface PCB provides:

- User setup of the NPB-40 via the keypad
- Patient %SpO2 and pulse rate via the display
- NPB-40 status via the display and audio function
- Printed reports via the IrDA (Infrared Data Association) and external printer
- Display readability in dark environments via the display backlight
- Operating voltages for the user interface circuits
- Operating voltage monitoring

Keypad

The user interface PCB keypad contains seven push buttons. These buttons allow the user to setup and control of the NPB-40. The buttons are:



1 — Alarm Silence	5 — Backlight
2 — Down Arrow	6 — Up Arrow
3 — Data	7 — Power
4 — Menu	

The signals from the buttons pass directly through the SpO_2 PCB and are applied to the user interface PCB CPU. The Power button signal is applied to the SpO_2 power supply turning the NPB-40 on or off.

Backlight

The backlight illuminates the display for better viewing.

CPU and Flash

The CPU controls all functions and timing for the NPB-40. The CPU communicates with the SpO_2 PCB patient interface. The patient interface signal are sent to the CPU for processing. The CPU sends signals to the patient sensor via the patient interface for controlling the sensor light levels.

Real-Time Clock

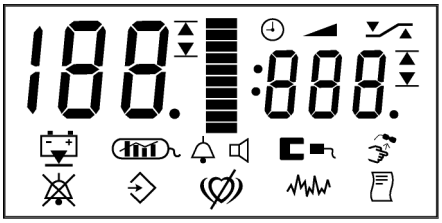
The real-time clock and non-volatile random access memory (RAM) chip maintain time and date used in the NPB-40. These circuits utilize a gold electrolytic super-capacitor for power when the NPB-40 is turned off.

Audio

The audio circuit drives a transducer to provide the NPB-40 tones.

LCD

The liquid crystal display (LCD) is driven by the CPU. The LCD displays the patient's %SpO_2 and pulse rate. The LCD also displays icons indicating the status and functions of the NPB-40. Refer to the NPB-40 Operator's manual for a description of the icons.



IrDA

The IrDA (Infrared Data Association) is an industry standard for infrared communications. The IrDA receives information from the CPU, converts it, and sends it to an external printer. The external printer communicates with the IrDA. Refer to the printer manual for more information.

Power Supply

The user interface PCB power supply receives power from the SpO_2 PCB power supply. The power supply provides a regulated 3.0 volts DC to the CPU.

Power Supply Monitoring

The power supply outputs are monitored by the power monitoring function to ensure stability. The power supply monitoring circuit sends a reset signal to the watchdog circuits to shut down the NPB-40 when voltages are out of tolerance.

The power supply monitoring circuit monitors the battery output voltage and shuts down the NPB-40 when the battery voltage is critically low. The circuit provides the low battery signal.

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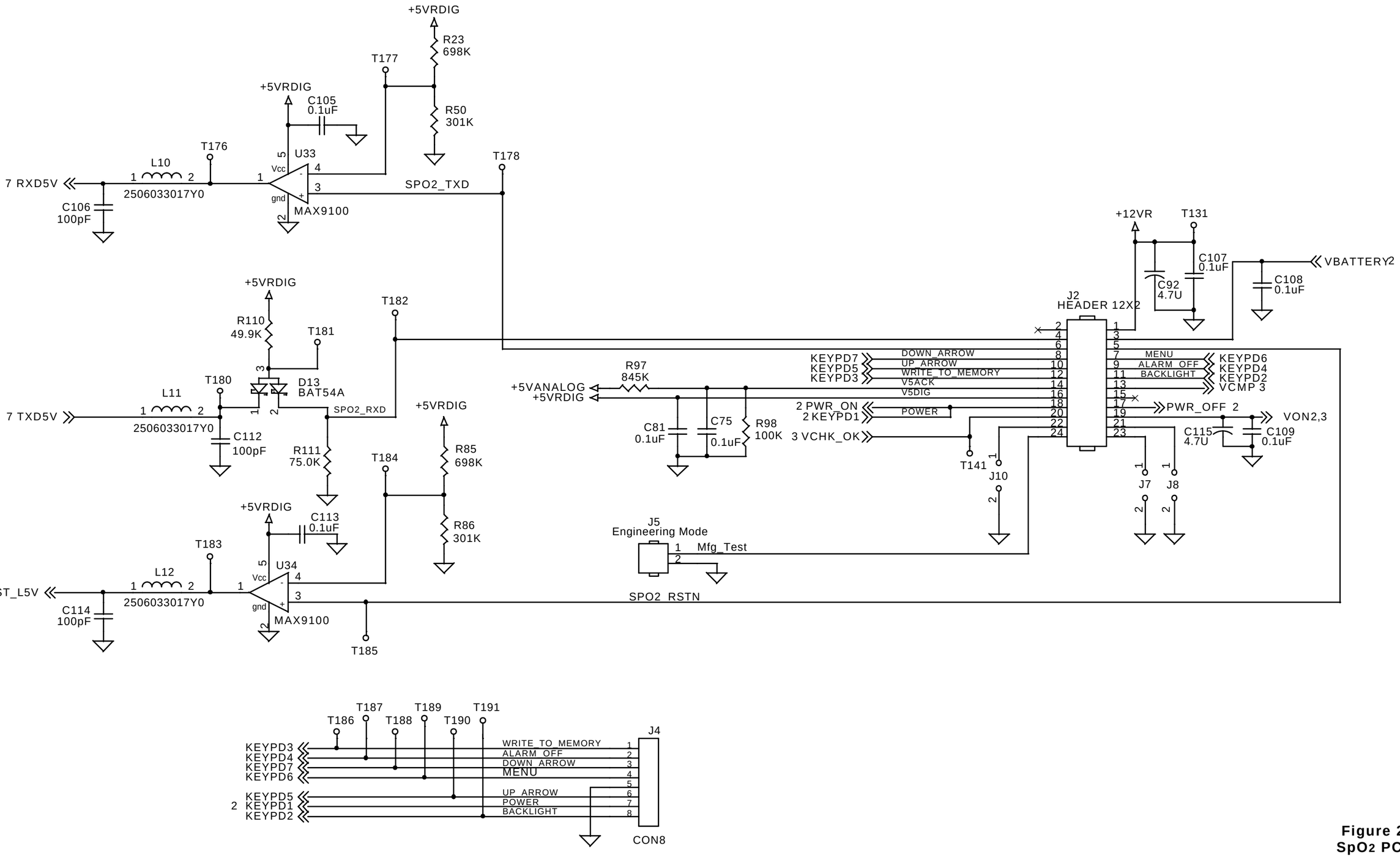

Figure 27
SpO2 PCB
Schematic Diagram
(sheet 1 of 7)

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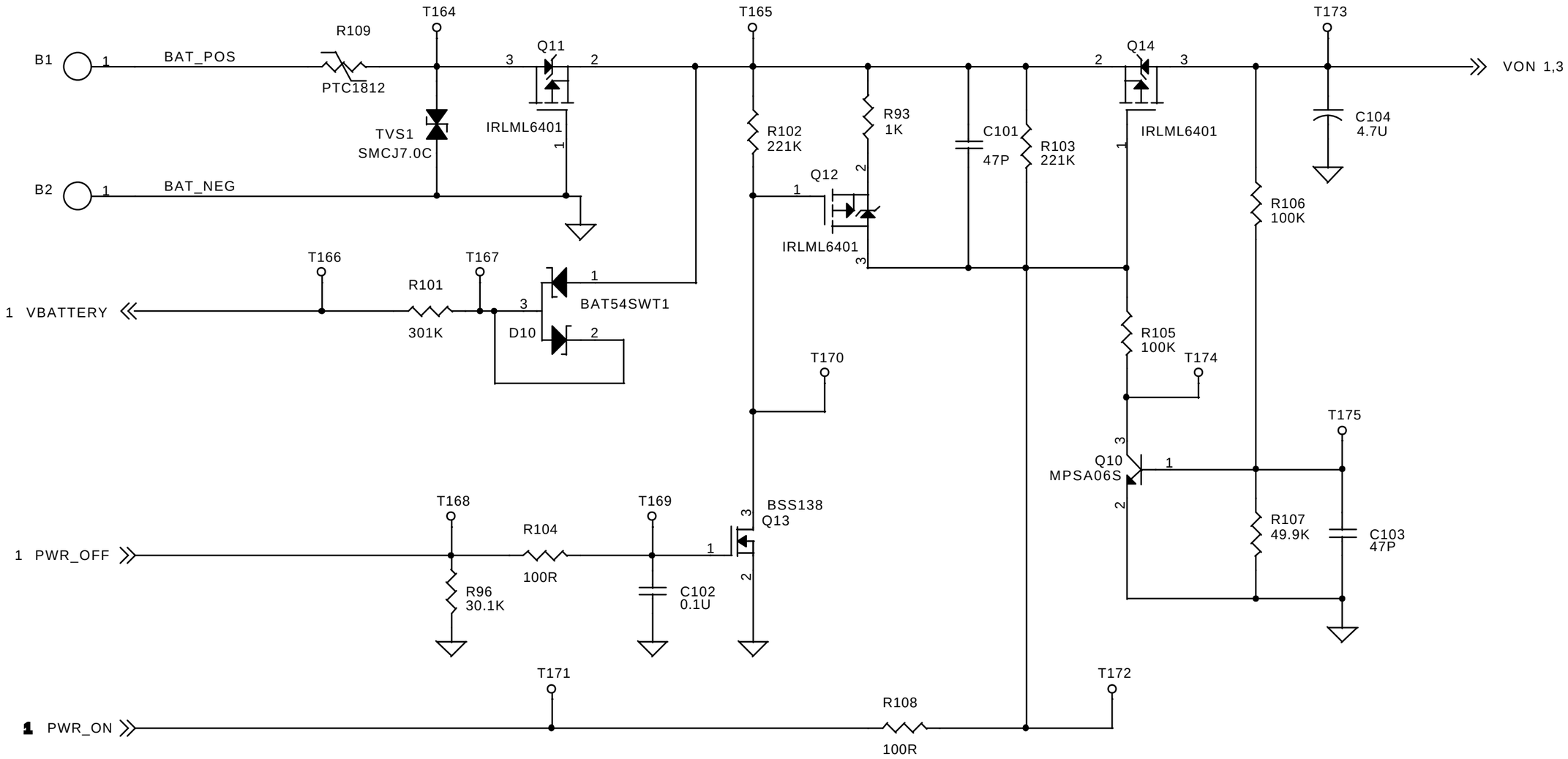

Figure 28
SpO2 PCB
Schematic Diagram
(Sheet 2 of 7)

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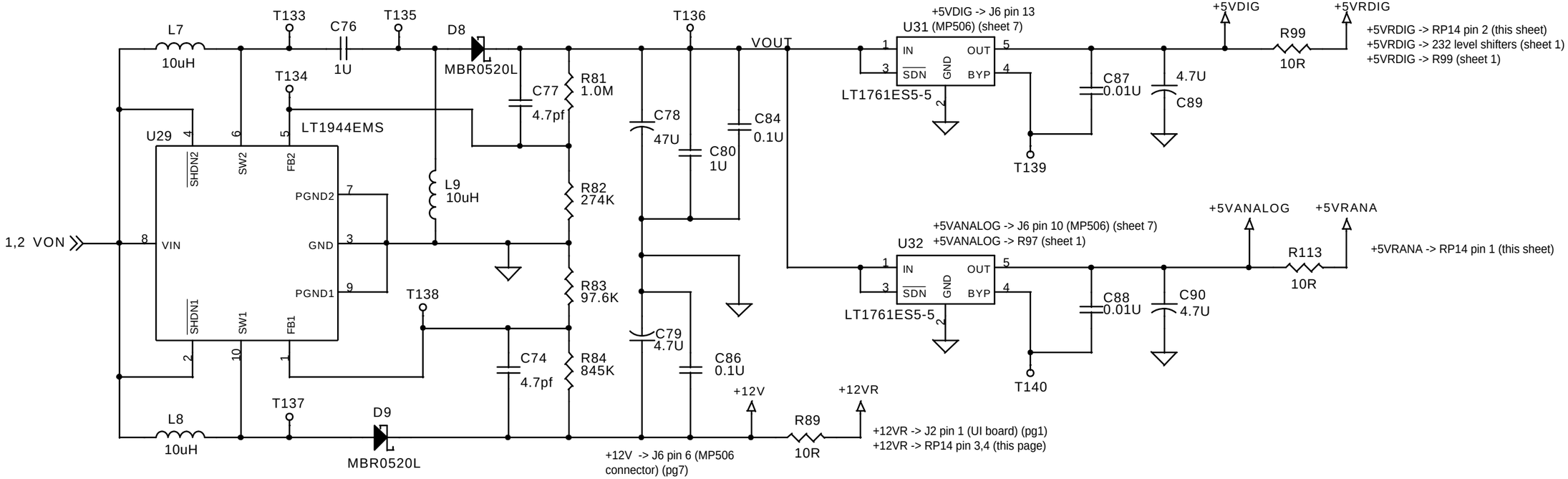

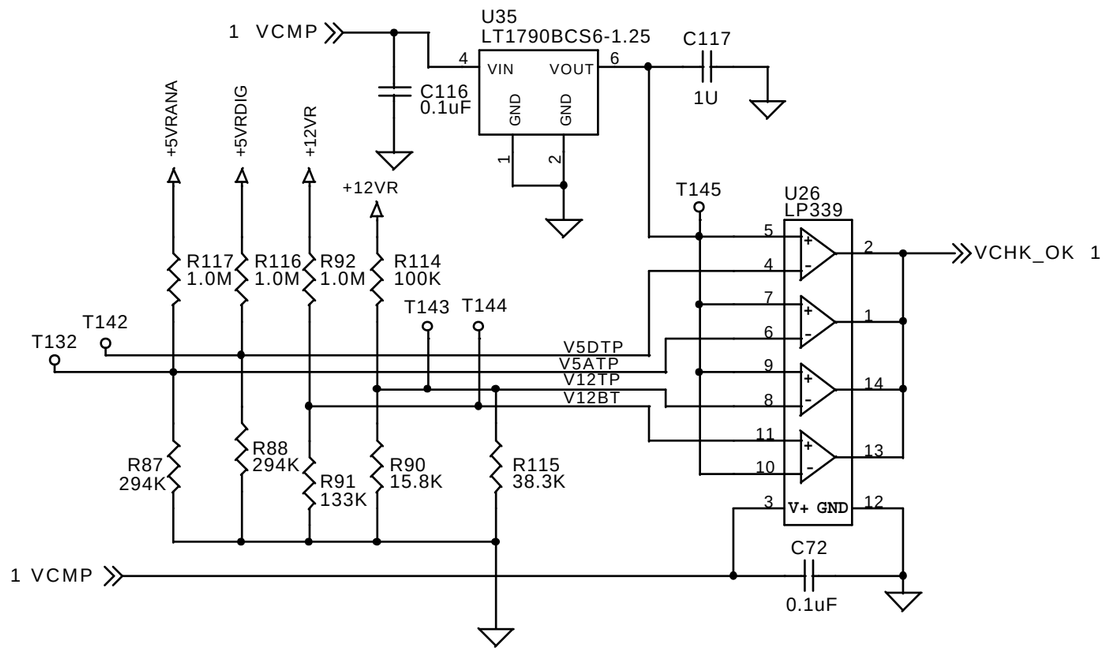

Figure 29
SpO2 PCB
Schematic Diagram
(Sheet 3 of 7)

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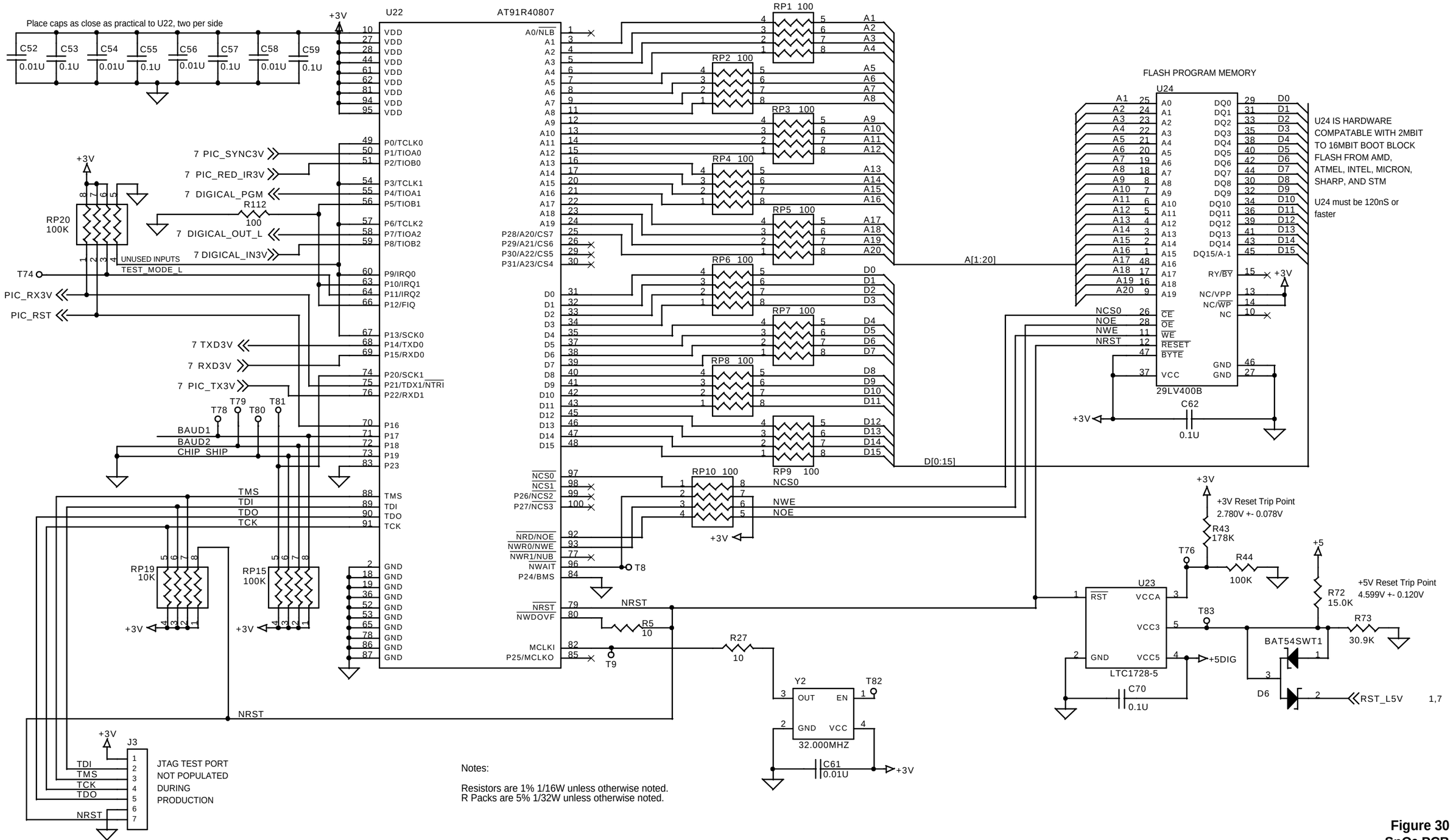

Notes:

Resistors are 1% 1/16W unless otherwise noted.
R Packs are 5% 1/32W unless otherwise noted.

Figure 30
SpO_2 PCB
Schematic Diagram
(Sheet 4 of 7)

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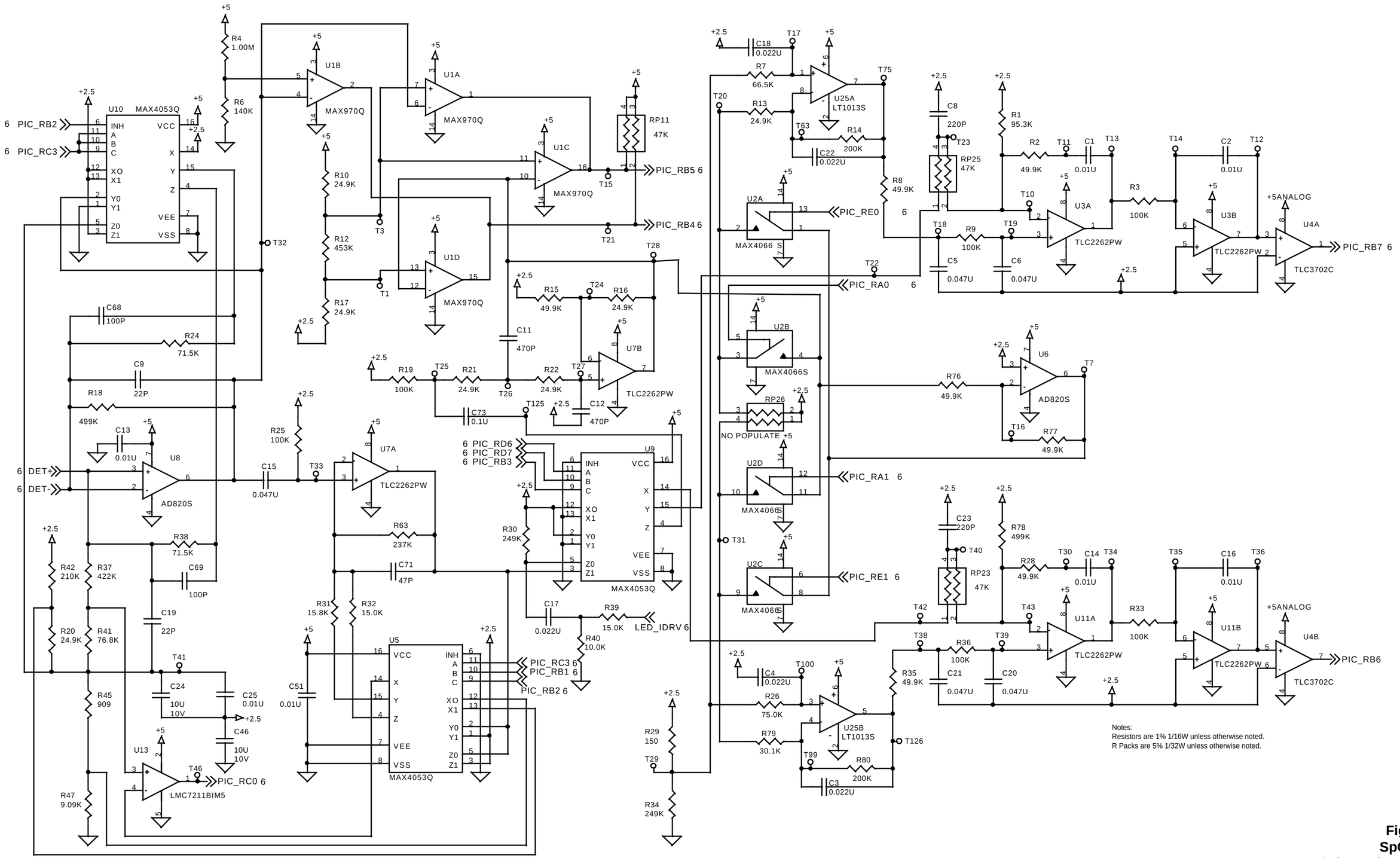

Figure 31
SpO2 PCB
Schematic Diagram
(Sheet 5 of 7)

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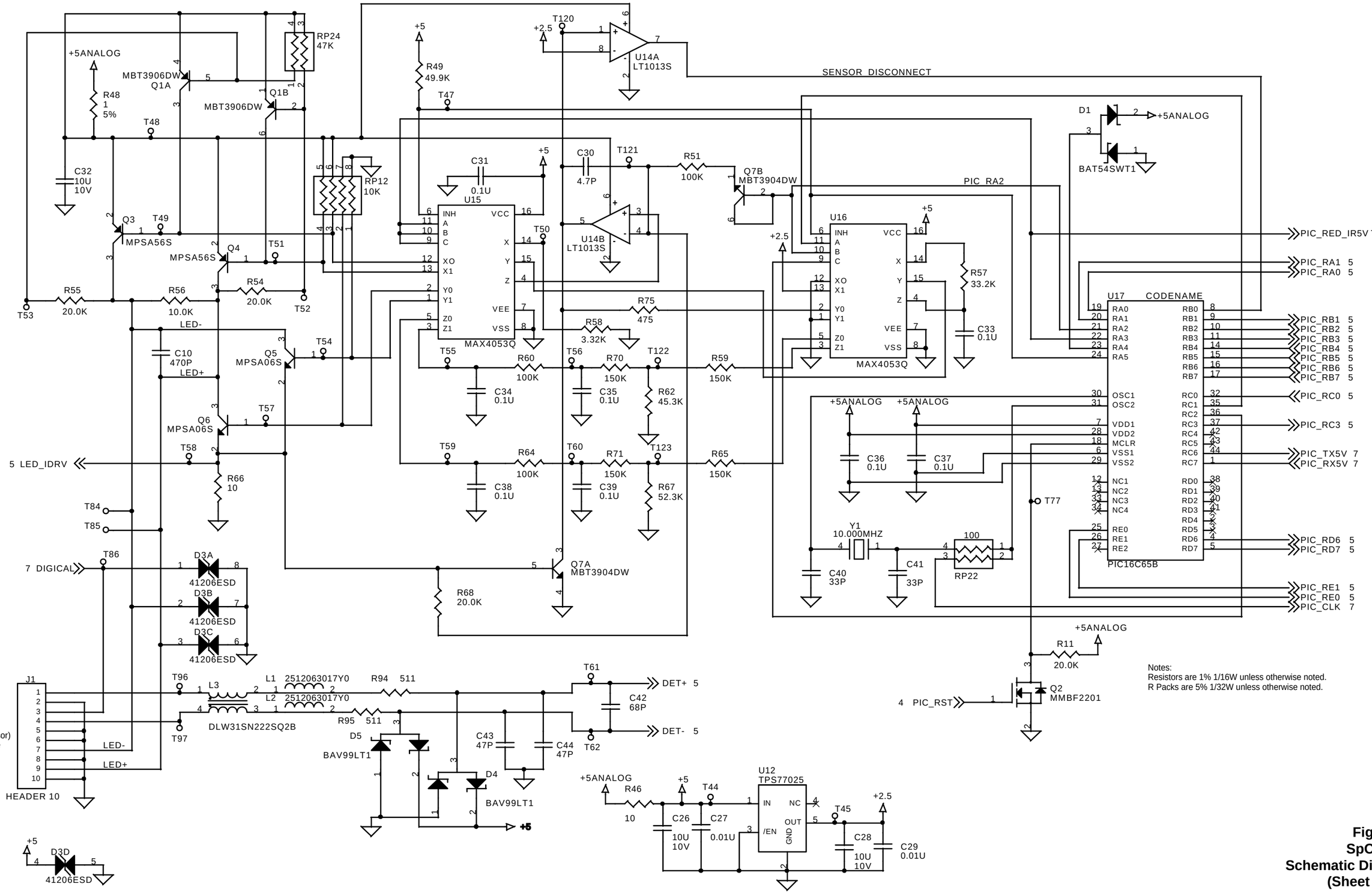

Figure 32
SpO2 PCB
Schematic Diagram
(Sheet 6 of 7)

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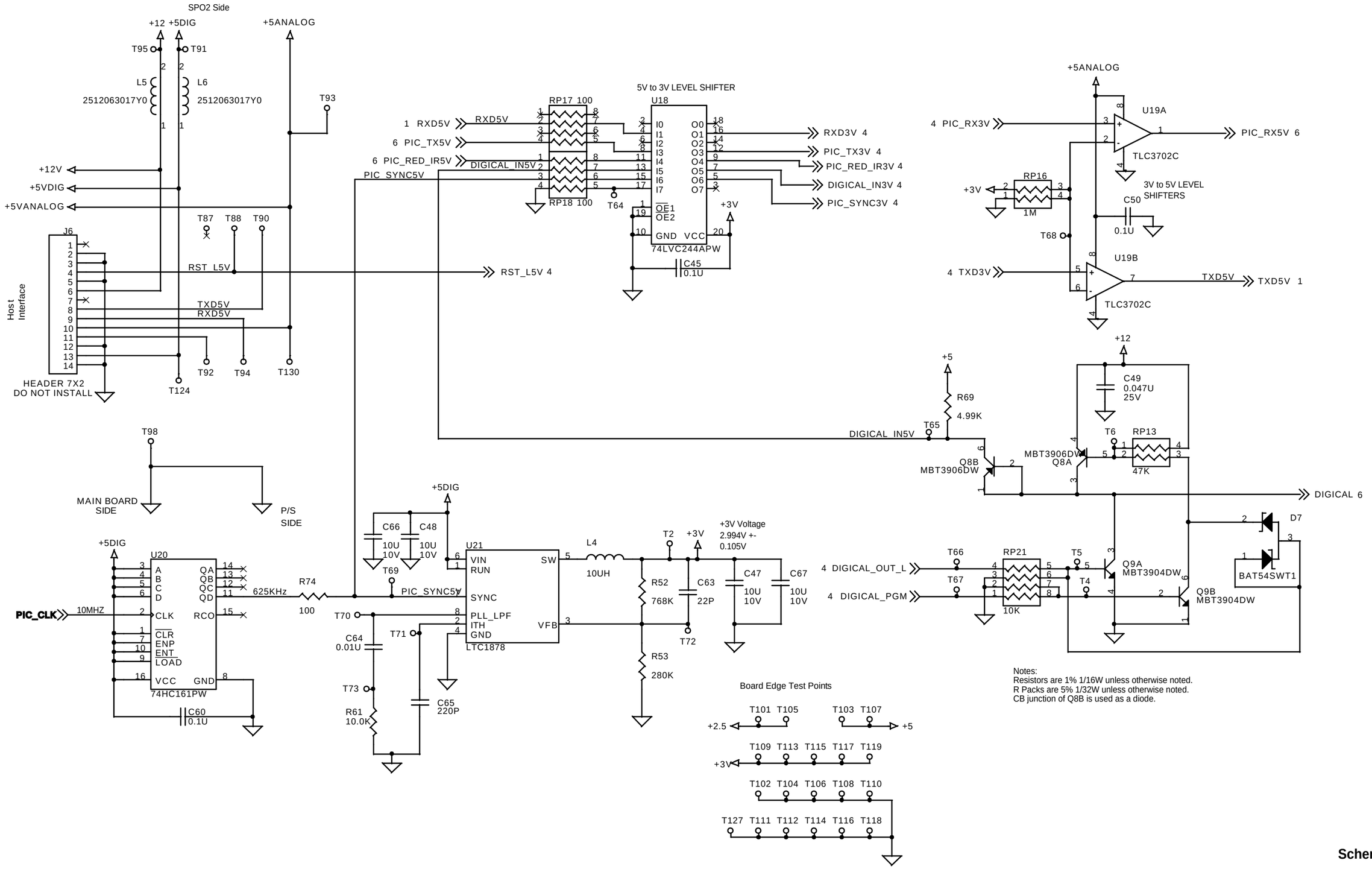

Figure 33
SpO2 PCB
Schematic Diagram
(Sheet 7 of 7)

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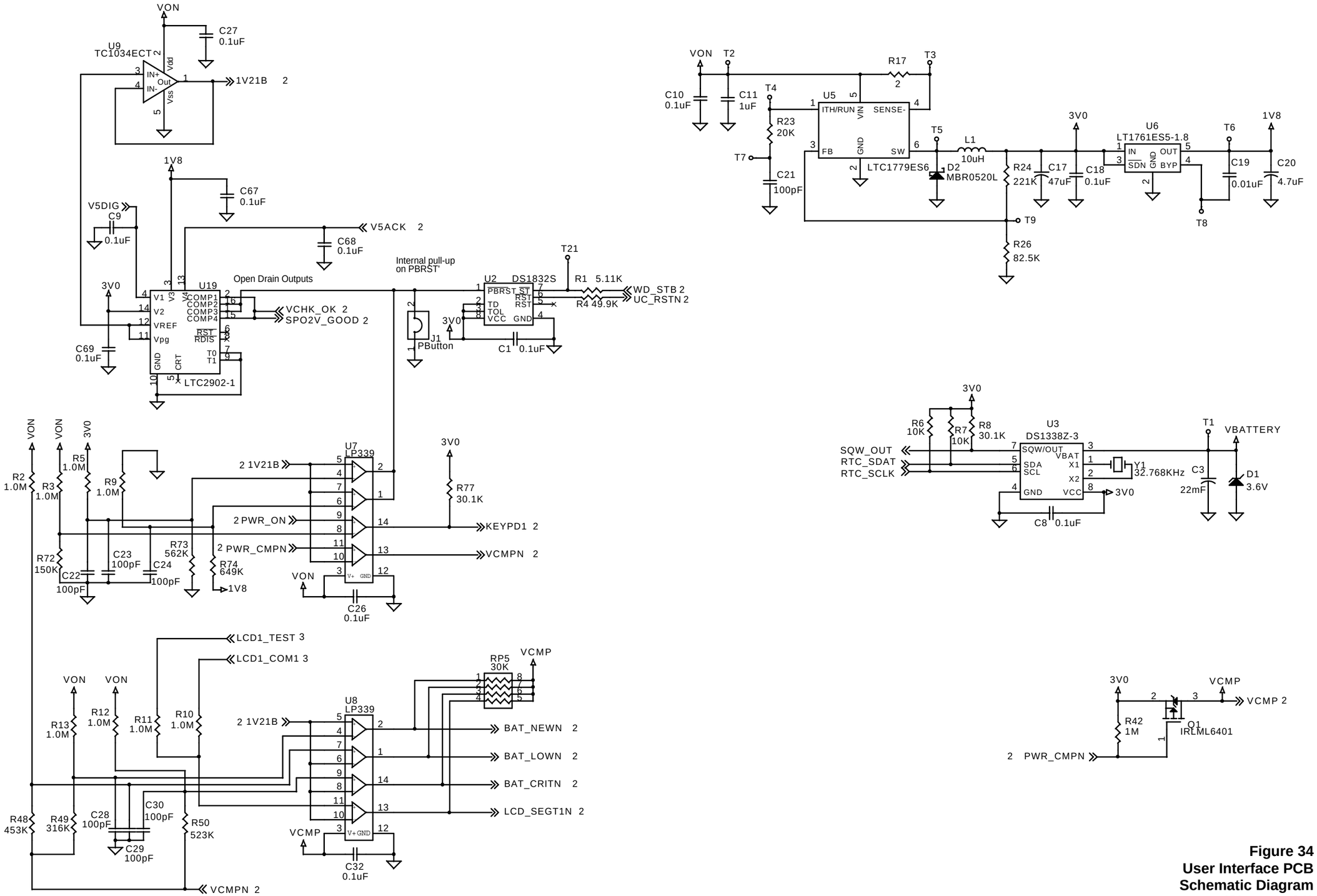

Figure 34
User Interface PCB
Schematic Diagram
(Sheet 1 of 3)

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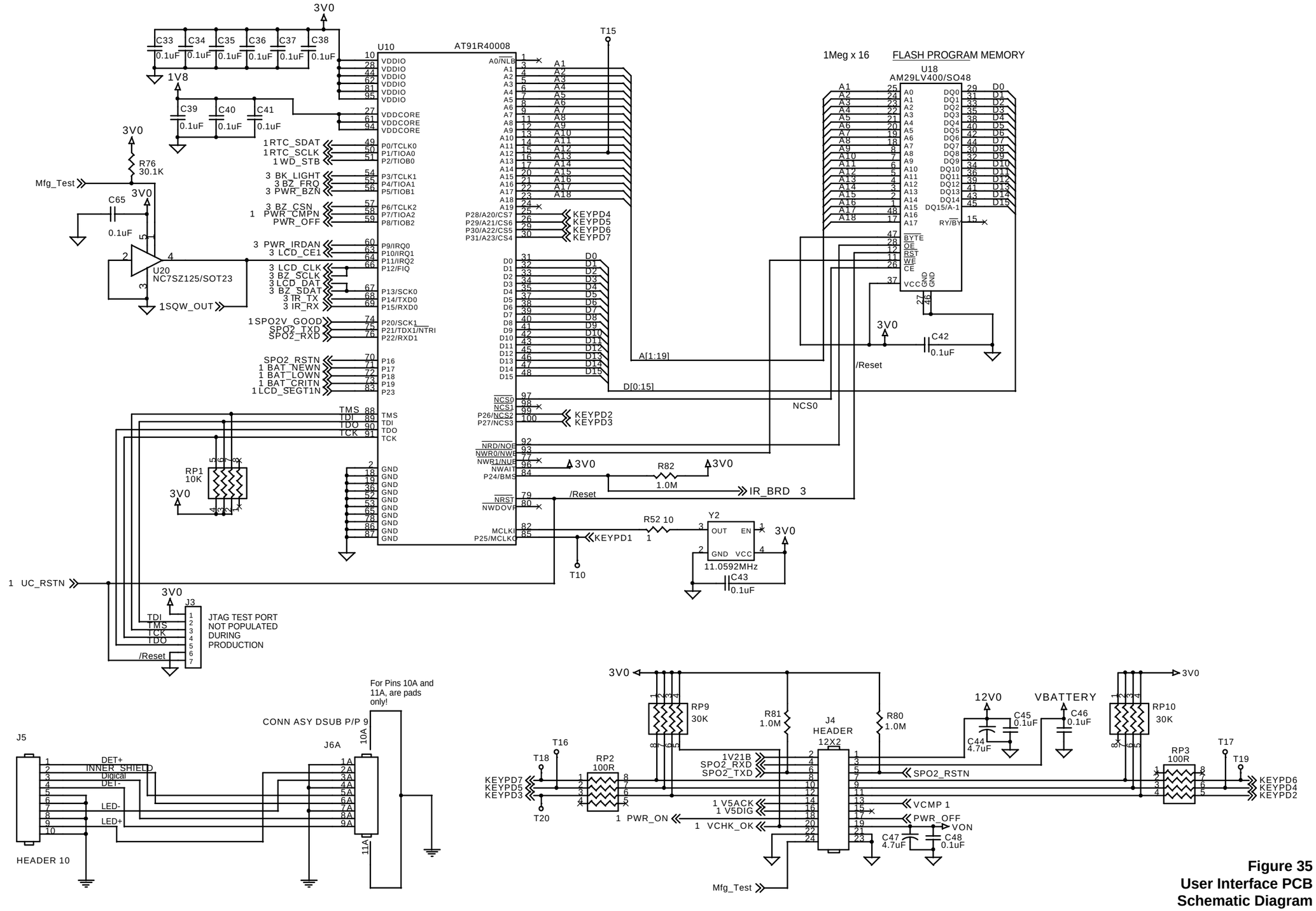

Figure 35
User Interface PCB
Schematic Diagram
(Sheet 2 of 3)

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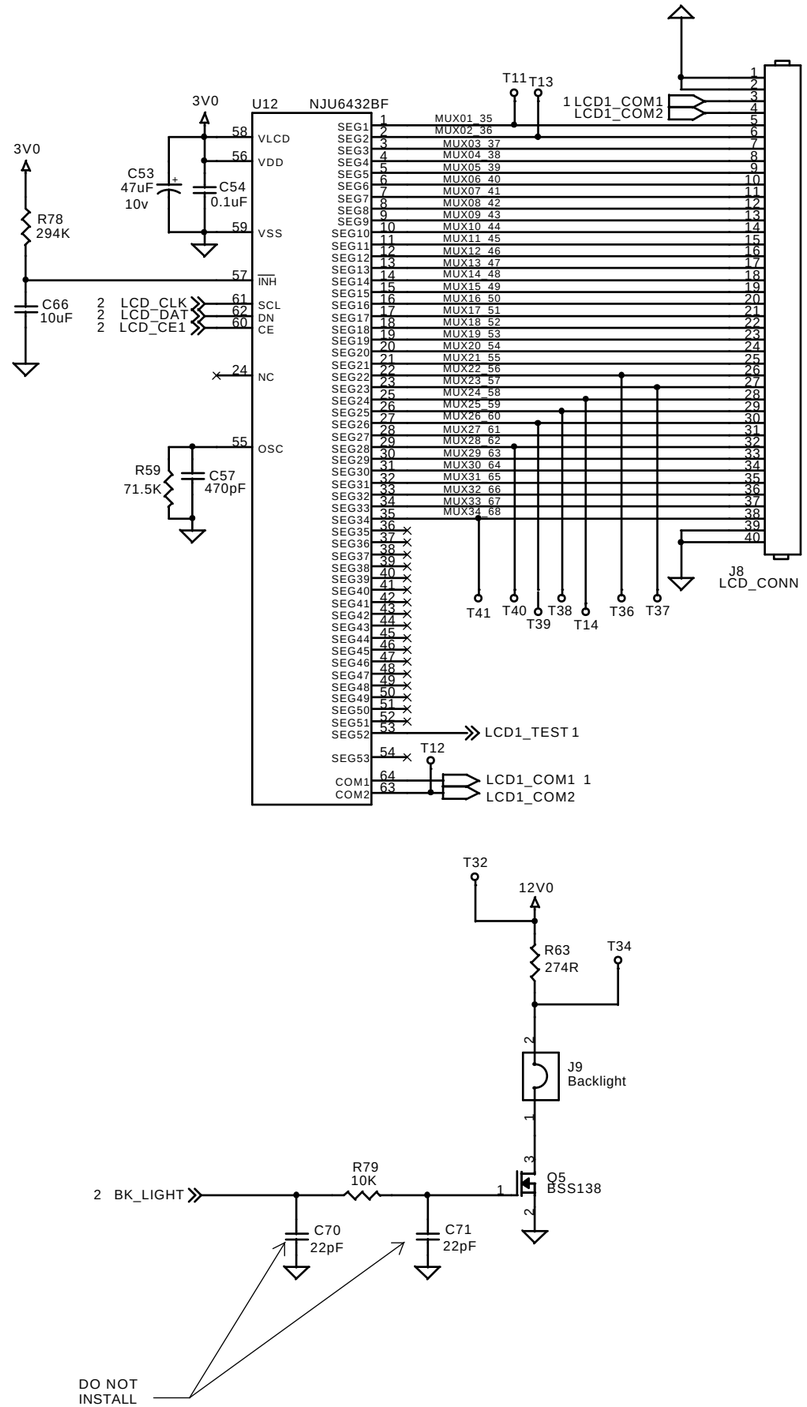

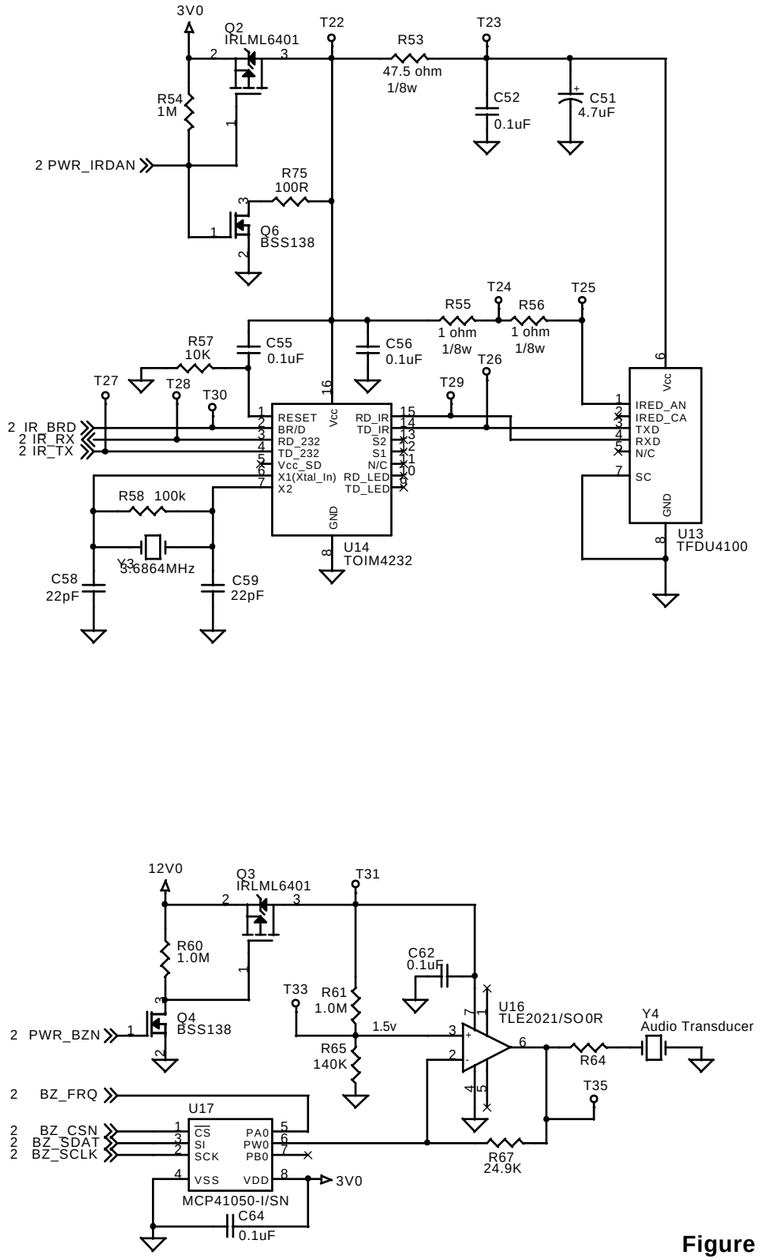

Figure 36
User Interface PCB Schematic Diagram (Sheet 3 of 3)

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