# WORKSHOP-IN-A-BOX 2: LOW POWER SOLUTIONS DEMONSTRATION BOARD

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# Preface

## NOTICE TO CUSTOMERS

**All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.**

**Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.**

**For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.**

## INTRODUCTION

The Low Power Solutions demonstration board is an ultrasonic range finder which demonstrates the nanoWatt capabilities of the PIC18 devices. The Low Power Solutions demonstration board can be used stand-alone with a programmed part, with an In-Circuit Emulator (e.g., MPLAB® ICE) or with an In-Circuit Debugger (e.g., MPLAB ICD 2). Items discussed in this chapter include:

- Document Layout
- Recommended Reading
- The Microchip Web Site
- Customer Support

## DOCUMENT LAYOUT

This document describes the Low Power Solutions demonstration board and demonstration software. Detailed information on individual microcontrollers may be found in the device's respective data sheet. Detailed information on MPLAB ICE (In-Circuit Emulator) or MPLAB ICD (In-Circuit Debugger) systems may be found in the respective tool's user guide.

- **Chapter 1:** Introduction – This chapter introduces the Low Power Solutions demonstration board and provides a brief description of the hardware.
- **Chapter 2:** Getting Started – This chapter goes through a basic step-by-step process for getting your Low Power Solutions demonstration board up and running as a stand-alone board or with an MPLAB ICE or MPLAB ICD.
- **Chapter 3:** Demonstration Software – This chapter provides a detailed description of the demonstration software.
- **Appendix A:** Hardware Description – This appendix describes in detail the hardware of the Low Power Solutions demonstration board

## RECOMMENDED READING

The following Microchip documents are available and recommended as supplemental reference resources. Documents may be obtained by downloading via the Microchip web site (www.microchip.com).

- Product Data Sheets and Reference Manuals:
  - PIC18F2525/2620/4525/4620 Data Sheet (DS39626)
  - PICmicro® 18C MCU Family Reference Manual (DS39500)
  - MCP6291/2/3/4/5 Data Sheet (DS21812)
  - TC1426/7/8 Data Sheet (DS21393)
  - TC1047 Data Sheet (DS21498)
- MPLAB® IDE Simulator, Editor User's Guide (DS51025)
- MPASM™ User's Guide with MPLINK™ Linker and MPLIB™ Librarian (DS33014)
- MPLAB® ICE User's Guide (DS51159)
- MPLAB® ICD 2 Quick Start Guide (DS51268)
- MPLAB® C18 C Compiler User's Guide (DS51288)

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- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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Technical support is available through the web site at: http://support@microchip.com

In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 – United States and most of Canada

1-480-792-7302 – Other International Locations

# Chapter 1. Low Power Solutions Demo Board Introduction

## 1.1 INTRODUCTION

The Low Power Solutions demonstration board is an ultrasonic range finder which demonstrates the nanoWatt capabilities of the PIC18 devices.

The Low Power Solutions demonstration board can be used stand-alone with a programmed part, with an in-circuit emulator (e.g., MPLAB® ICE) or with an in-circuit debugger (e.g., MPLAB ICD 2).

Software to operate the ultrasonic range finder is provided. It has not been optimized to minimize power consumption, this is left as an exercise for the user.

The Workshop-in-a-Box 2 Kit comes with the following:

1. Low Power Solutions demonstration board (Figure 1-1)
2. PIC18F4620 device
3. Low Power Solutions Demonstration Board CD-ROM, which contains:
   a) Demonstration Software
   b) Lab templates for hands-on exercises
   c) PIC18F4620 Data Sheet (DS39626)
   d) Low Power Solutions Demonstration Boards User's Guide (DS51512)
   e) Labs Write-up (DS39667)
   f) 8-bit PIC Microcontroller Solutions Brochure (DS39630)
   g) PICmicro Power Managed Tips 'n Tricks (DS41200)
   h) Power Managed PIC Microntrollers Featuring nanoWatt Technology Brochure (DS30493)
   i) Low Power Features of the nanoWatt Family Devices Presentation
   j) Self-paced Learning Presentations
4. Microchip Technology Development Tool CD-ROM, containing:
   a) MPLAB IDE
   b) MPLAB C18 Compiler (trial version)

Optional material for exercise (not provided) include:

1. Current Meter
2. Current Meter Connector

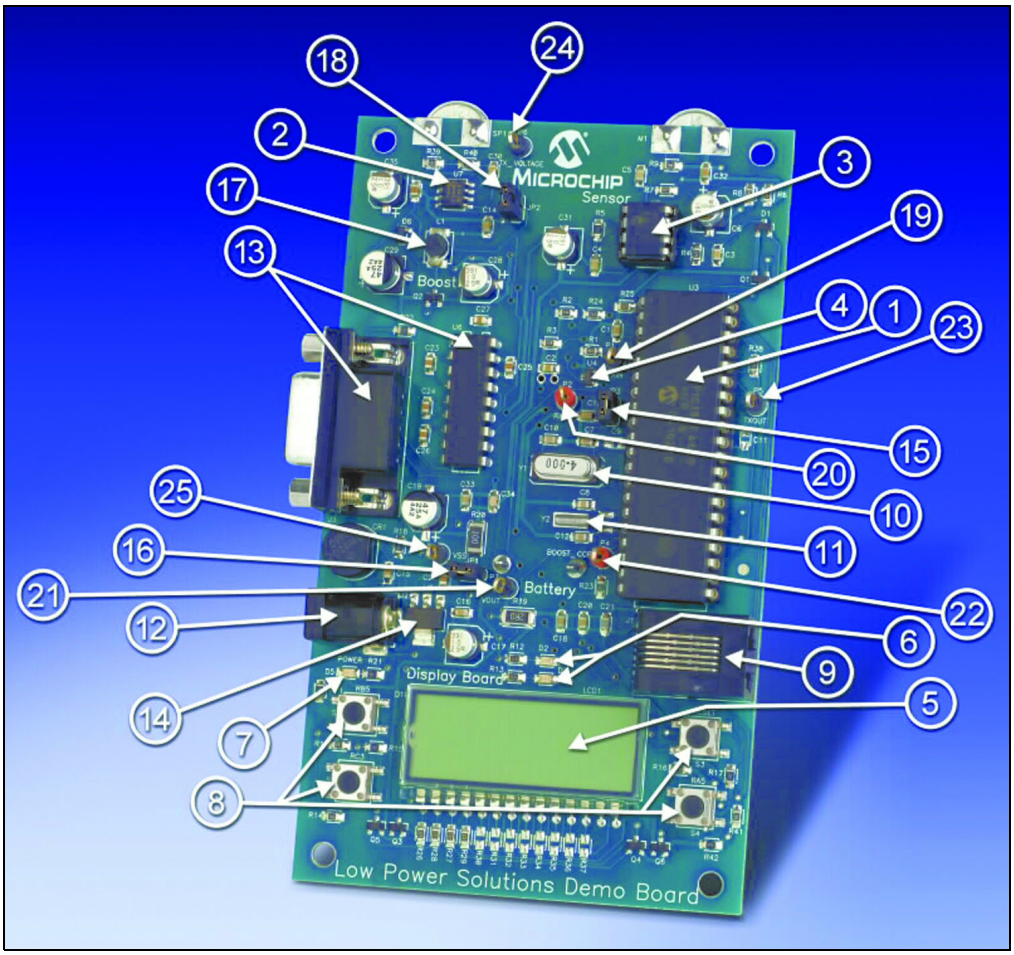
If you are missing any part of the kit, please contact your nearest Microchip sales office listed in the back of this publication for help.

## 1.2 LOW POWER SOLUTIONS DEMONSTRATION BOARD

The Low Power Solutions demonstration board has the following hardware features:

1. PIC18F4620 featuring nanoWatt Technology
2. Ultrasonic transmitter featuring Microchip Technology TC1428 CMOS Driver
3. Ultrasonic receiver featuring Microchip Technology MCP6293 Op-amp
4. Microchip Technology TC1047A temperature sensor
5. Static LCD display
6. 2 LEDs connected to RA4 and RC5
7. Green power-on indicator LED
8. Four push button switches for external stimulus and Reset
9. MPLAB ICD 2 connector
10. 4MHz crystal connected to OSC1 and OSC2
11. 32KHz crystal for Timer1 clock operations
12. Power supply connector
13. RS-232 socket and associated hardware for direct connection to an RS-232 interface
14. On-board +5V regulator for direct input from 9V AC/DC wall adapter or 9V battery
15. Jumper JP3 to measure PICmicro current consumption with current meter
16. Jumper JP1 to measure system current consumption with current meter
17. 5V to 10V boost power supply
18. Jumper JP2 to disconnect boost power supply from ultrasonic transmitter
19. Receiver output test point
20. External reference test point
21. 5V test point
22. Boost PWM test point
23. Transmitter PWM test point
24. Boost output test point
25. VSS test point

**FIGURE 1-1: LOW POWER SOLUTIONS DEMONSTRATION BOARD HARDWARE**




## 1.3 LOW POWER SOLUTIONS DEMONSTRATION BOARD DEFAULT DEMONSTRATION

The Low Power Solutions demonstration board is a functional, short distance range finder. Once enabled, it repeatedly measures distance and updates the display. The distance is displayed in centimeters on the LCD. It continues to run for approximately one minute, pauses until SW1 is pressed, then restarts the process. The range finder is capable of measuring up to 60 cm.

**NOTES:**

# Chapter 2. Getting Started

## 2.1 INTRODUCTION

The Low Power Solutions demonstration board may be used as a stand-alone board with a preprogrammed device, with an MPLAB® ICE (In-Circuit Emulator) or MPLAB ICD (In-Circuit Debugger) system. For a list of PICmicro® microcontroller compatible MPLAB ICE (In-Circuit Emulator) or MPLAB ICD (In-Circuit Debugger) systems, please refer to the *Development Systems Ordering Guide* (DS30177).

## 2.2 LOW POWER SOLUTIONS DEMONSTRATION BOARD AS A STAND-ALONE BOARD – PREPROGRAMMED DEVICE

The Low Power Solutions demonstration board features a PIC18F4620 preprogrammed with functional range finder software. It can be demonstrated by following the steps listed below:

- Verify that jumpers JP1, JP2 and JP3 are closed (shorted).
- Apply power to the Low Power Solutions demonstration board. For information on acceptable power sources, see Appendix A.

To reprogram the sample device, the following will be necessary:

1. Program source code. User source code may be used to program the device or, if this has previously been done, the sample program may be restored from the file on the included CD-ROM.
2. MPLAB C18 may be used to modify the source code and the hex file can be programmed into the device. The demonstration and tutorial software are written using Microchip Technology's MPLAB C18 C compiler.
3. MPLAB ICD 2 (programmer functionality available with MPLAB IDE v6.00 or greater) can be connected to the Low Power Solutions demonstration board. Once the sample program is in hex file format, MPLAB ICD 2 may be used to program the PIC18F4620 or similar device.

## 2.3 THE LOW POWER SOLUTIONS DEMONSTRATION BOARD USED WITH AN IN-CIRCUIT EMULATOR OR IN-CIRCUIT DEBUGGER

To use Low Power Solutions demonstration board with an MPLAB ICE (In-Circuit Emulator) or MPLAB ICD (In-Circuit Debugger) system, refer to the tool's user guide for instructions on how to power-up and configure the MPLAB ICE/MPLAB ICD, as well as how to connect to target boards.

**Note:** The provided stand-offs can be configured to allow the demonstration board to stand up vertically. Pass the threaded end of each post through a hole in the board near the "Low Power Solutions Demo Board" label and fasten another stand-off to the first.

**NOTES:**

# Chapter 3. Demonstration Software

## 3.1 INTRODUCTION

The demonstration program is preprogrammed into the sample device, (`WIB2demo.hex`). Also, this program is on the included CD-ROM program disk for user reference, (i.e., if the sample device has been reprogrammed with another program, the tutorial may be reprogrammed into the device).

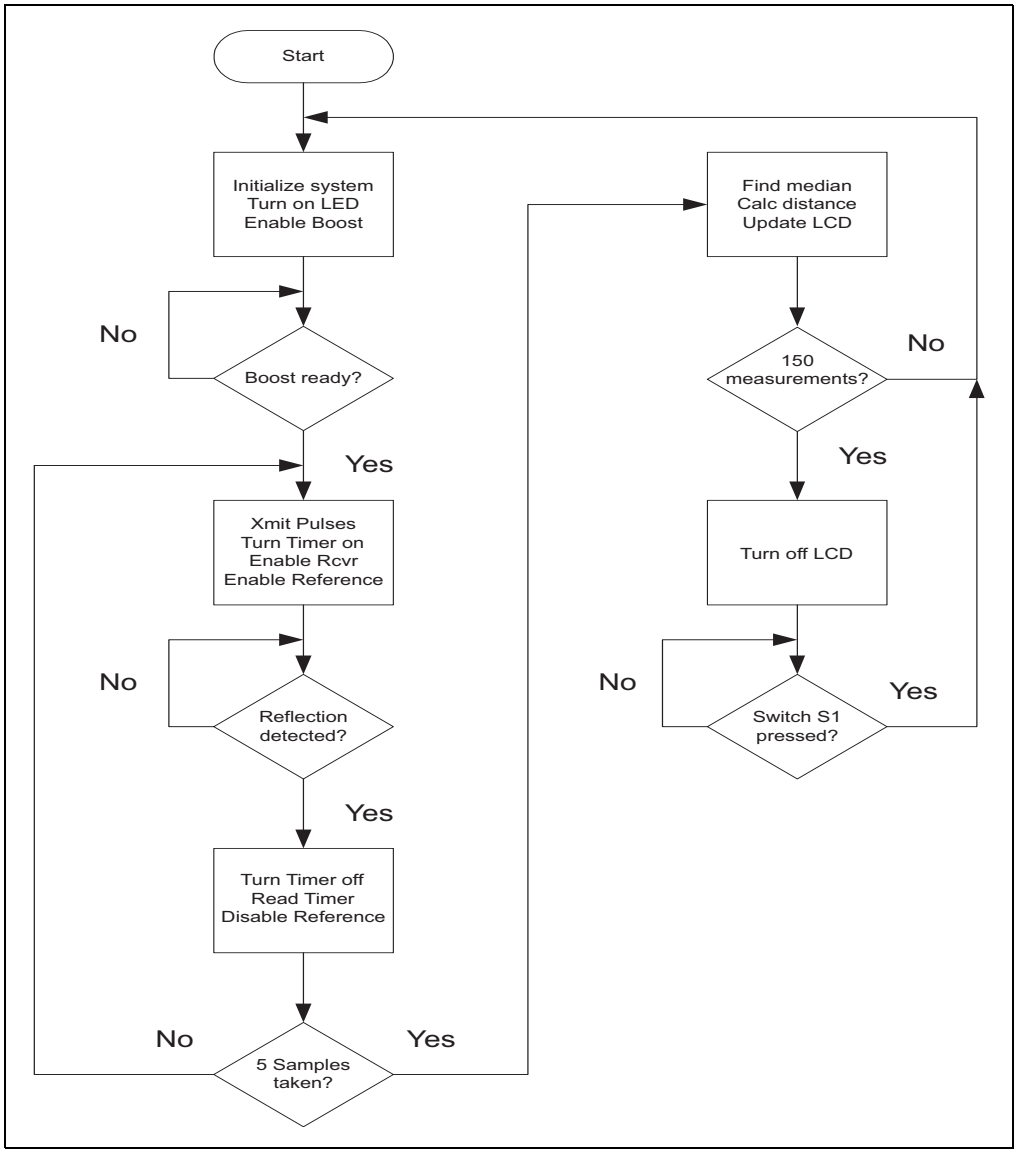
For detailed information on the Low Power Solutions demonstration board hardware, please refer to Appendix A.

## 3.2 TUTORIAL PROGRAM OPERATION

The provided demonstration program enables the Low Power Solutions demonstration board to measure short distances using ultrasonic reflections (see Figure 3-1). This program does not implement all system or PICmicro power management improvements. These improvements are left as an exercise for the user. Refer to the hands-on write-up on the included CD for additional information on the exercises.

On power-up, the distance is repeatedly measured and the distance is displayed on the LCD in centimeters. After approximately one minute, the process stops and waits for SW1 to be pressed. After pressing SW1, the sequence restarts. The Low Power Solutions demonstration board is capable of measuring distances up to 60 cm. The distance is largely dependent on how hard, flat and large the reflected surface is.

**FIGURE 3-1: DEMONSTRATION PROGRAM STATE DIAGRAM**



# Appendix A. Hardware Detail

## A.1 INTRODUCTION

The Low Power Solutions Demo Board hardware is intended to illustrate the ease of use of nanoWatt features of PIC18 MCUs. The Low Power Solutions Demo Board features the following hardware elements:

### A.1.1 Power Supply

There are two ways to supply power to the Low Power Solutions Demo Board:

- A 9V battery can be plugged into the connector on the back of the board.
- A 9V, 100 mA unregulated AC or DC supply can be plugged into J2.

A power supply can be purchased through Microchip, Part #AC162039. MPLAB ICD 2 users may use the MPLAB ICD to power the target board to 5V, up to 200 mA, if the MPLAB ICD 2 is connected to the PC with a serial cable. The green LED (D5) will be lit when power is applied.

### A.1.2 RS-232 Serial Port

An RS-232 level shifting IC has been provided with all necessary hardware to support connection of an RS-232 host through the DB9 connector. The port is configured as DCE and can be connected to a PC using a straight-through cable.

The PIC18 RX and TX pins are tied to the RX and TX lines of the LT1280A. The driver can be put into a low power state by outputting a logic level low on RC4.

### A.1.3 Switches

Three switches provide the following functions:

- S1 – Active-low switch connected to RB5
- S2 – Active-low switch connected to RC3
- S3 – MCLR to hard reset the processor
- S4 – Active-low switch connected to RA5

When pressed, the switches are grounded. When Idle, they are pulled high (+5V).

### A.1.4 Oscillator Options

- 4 MHz crystal for OSC1 and OSC2 supplied.
- 32.768 kHz (watch type) crystal for Timer1.

### A.1.5 ICD Connector

By way of the modular connector (J1), the MPLAB ICD 2 can be connected for low-cost debugging. The ICD connector utilizes RB6 and RB7 of the microcontroller for in-circuit debugging.

### A.1.6 Temperature Sensor

This is a serial digital thermal sensor (TC1047A) connected to RE2. The sensor outputs an analog voltage representation of the temperature.

### A.1.7 LCD

A 3-1/2 digit, seven segment LCD display displays the distance in centimeters. There are eight segment lines (RD7:RD0) and four common lines (RB4, RB2:RB0). A software algorithm generates the LCD waveforms. The board layout also supports four seven segment LED modules if the LCD display is removed. The software to control the LED display is not provided.

### A.1.8 DC Boost Circuit

The boost generates a 10V output from a 5V source. The output voltage is modulated and doubled using a CMOS Driver (TC1428), to produce a 20V, 40 KHz pulse sequence for the ultrasonic transmitter.

### A.1.9 Receiver

The ultrasonic receiver output is conditioned and amplified using an op-amp (MCP6293) which features a pin selectable low-power mode. The low power mode is enabled by outputting a logic level high on RE1.

### A.1.10 Board Layout And Schematics

The following figures show the parts layout (silkscreen) and schematics for the Low Power Solutions Demo Board.

**FIGURE A-1: LOW POWER SOLUTIONS DEMO BOARD PARTS LAYOUT**

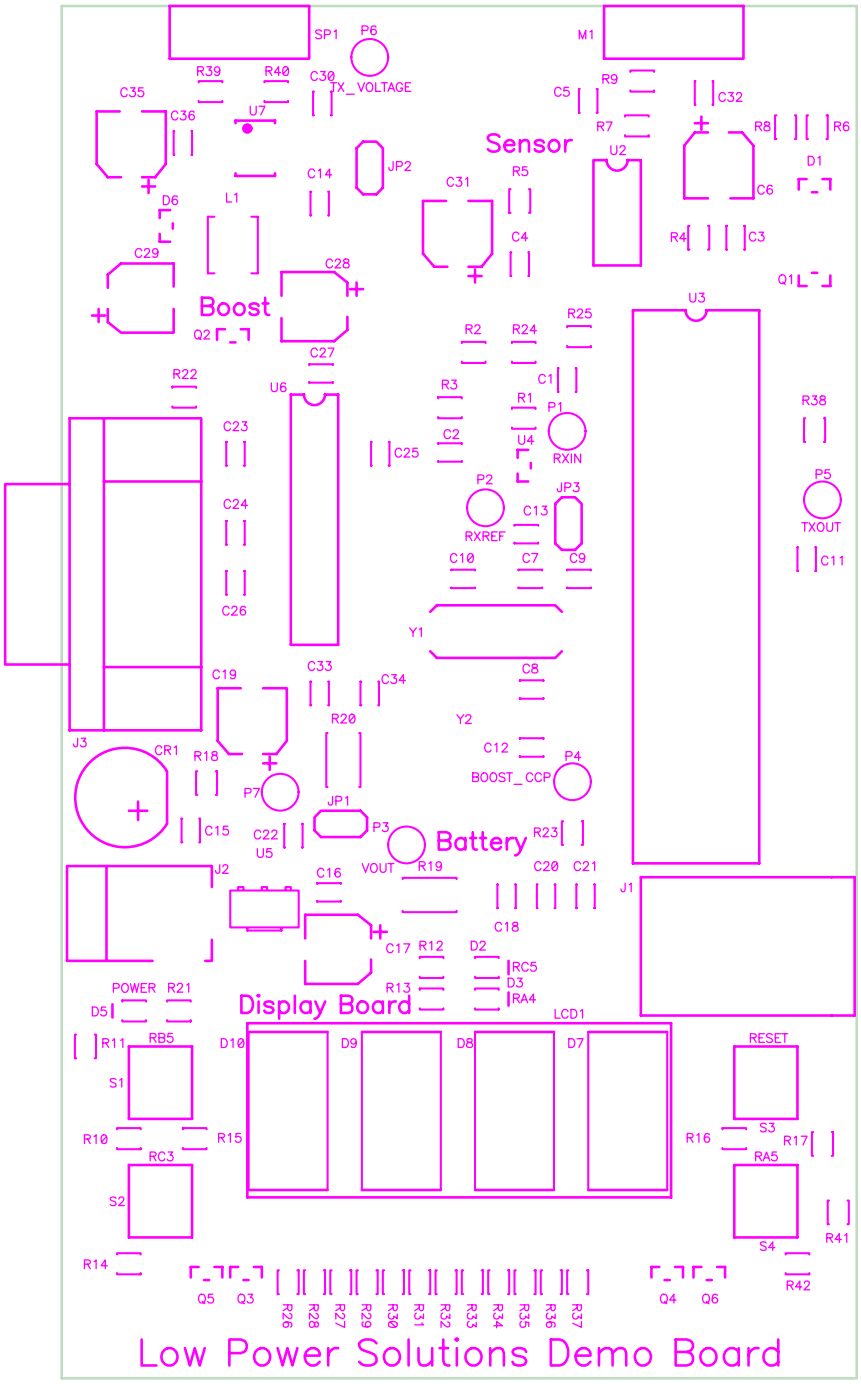


**FIGURE A-2: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 1**

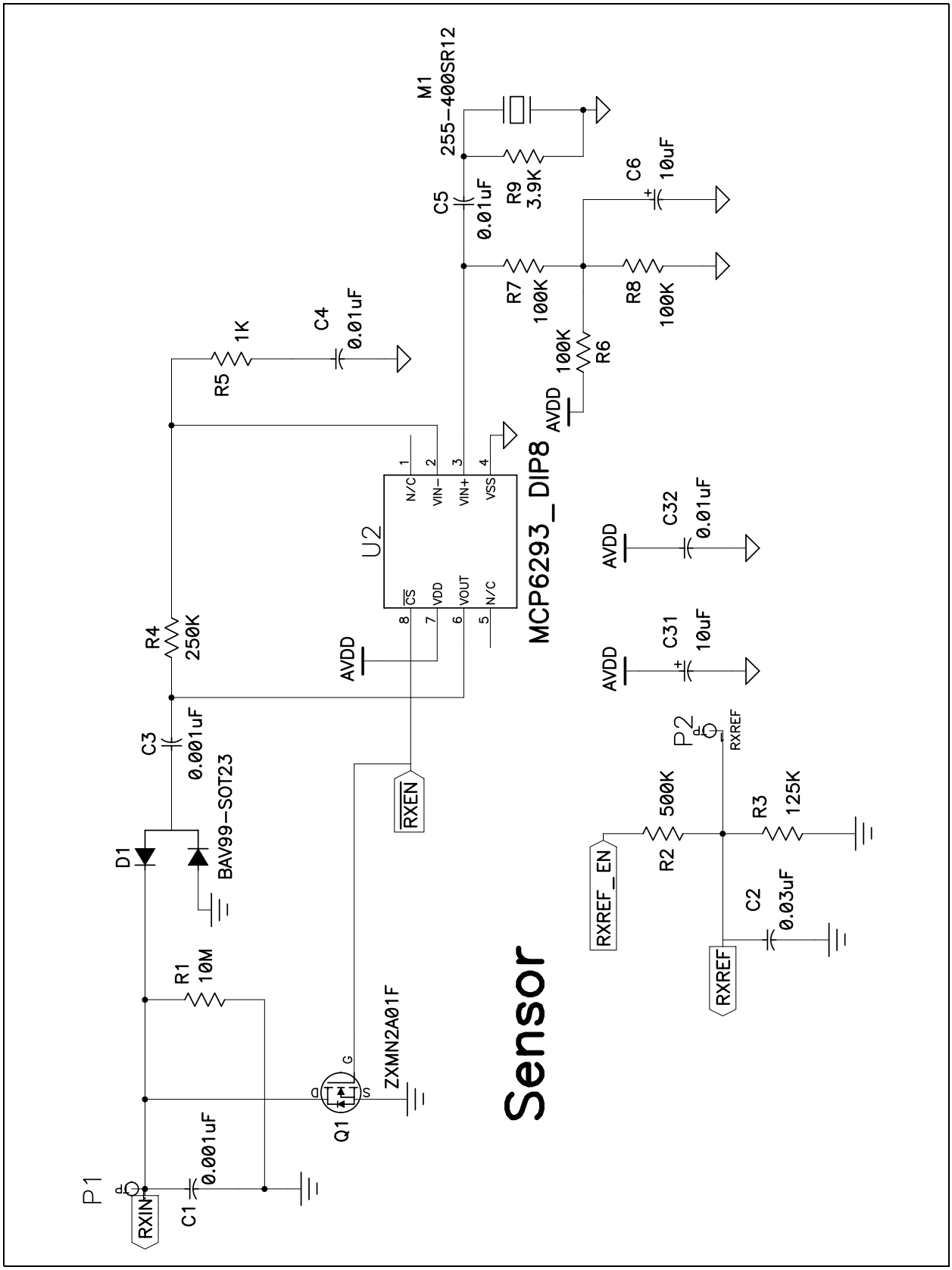


**FIGURE A-3: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 2**

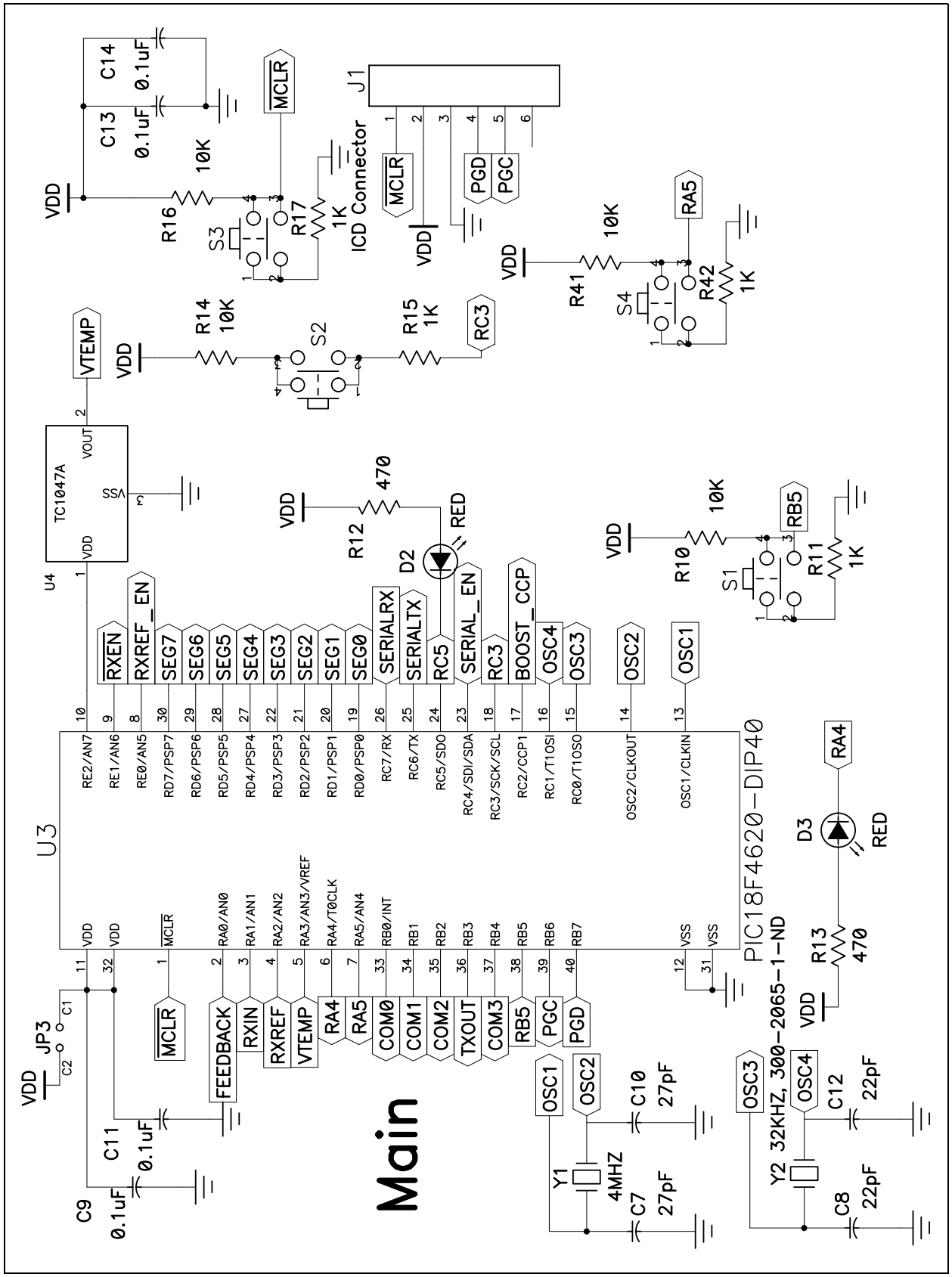


**FIGURE A-4: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 3**

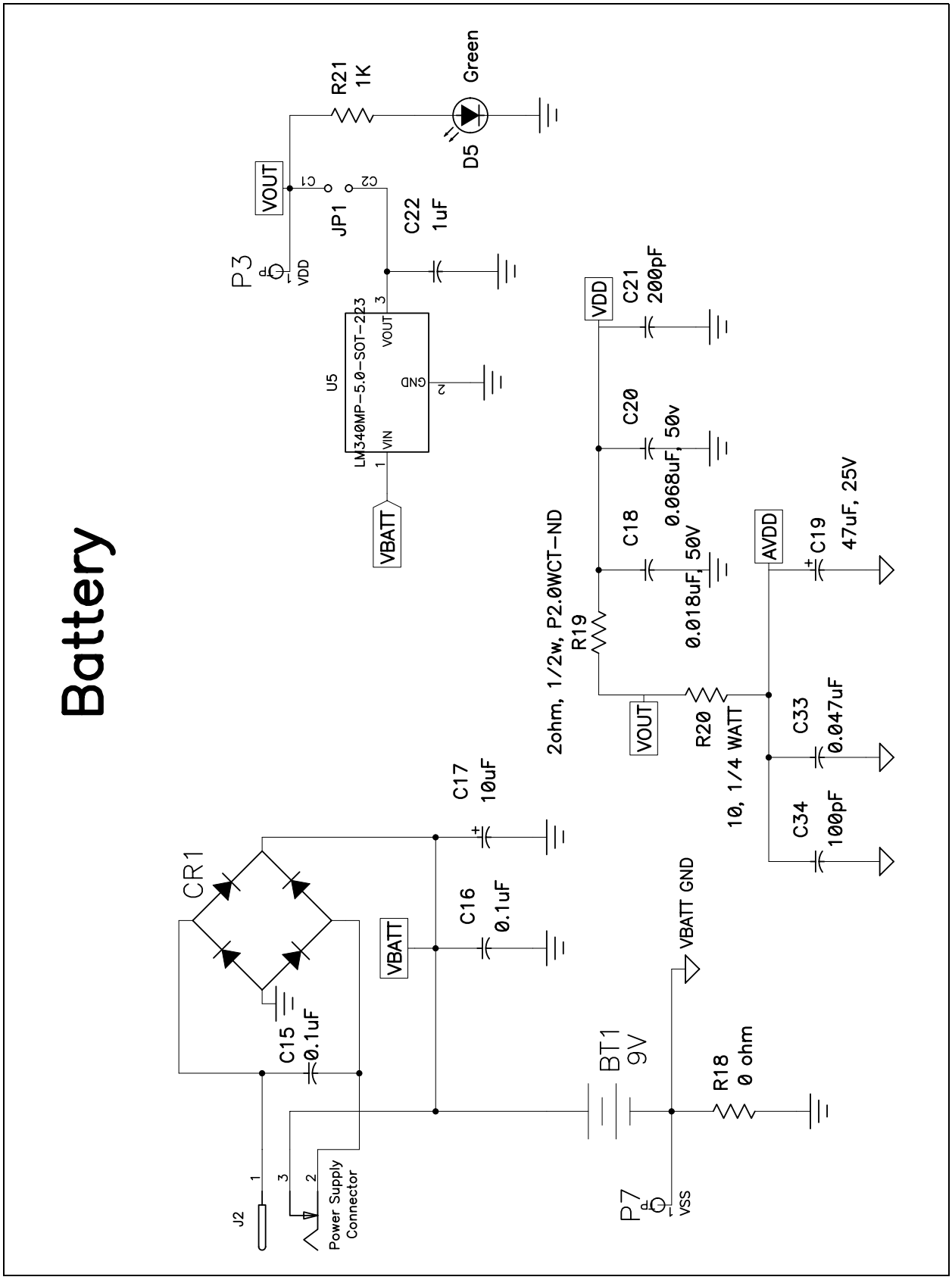


**FIGURE A-5: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 4**

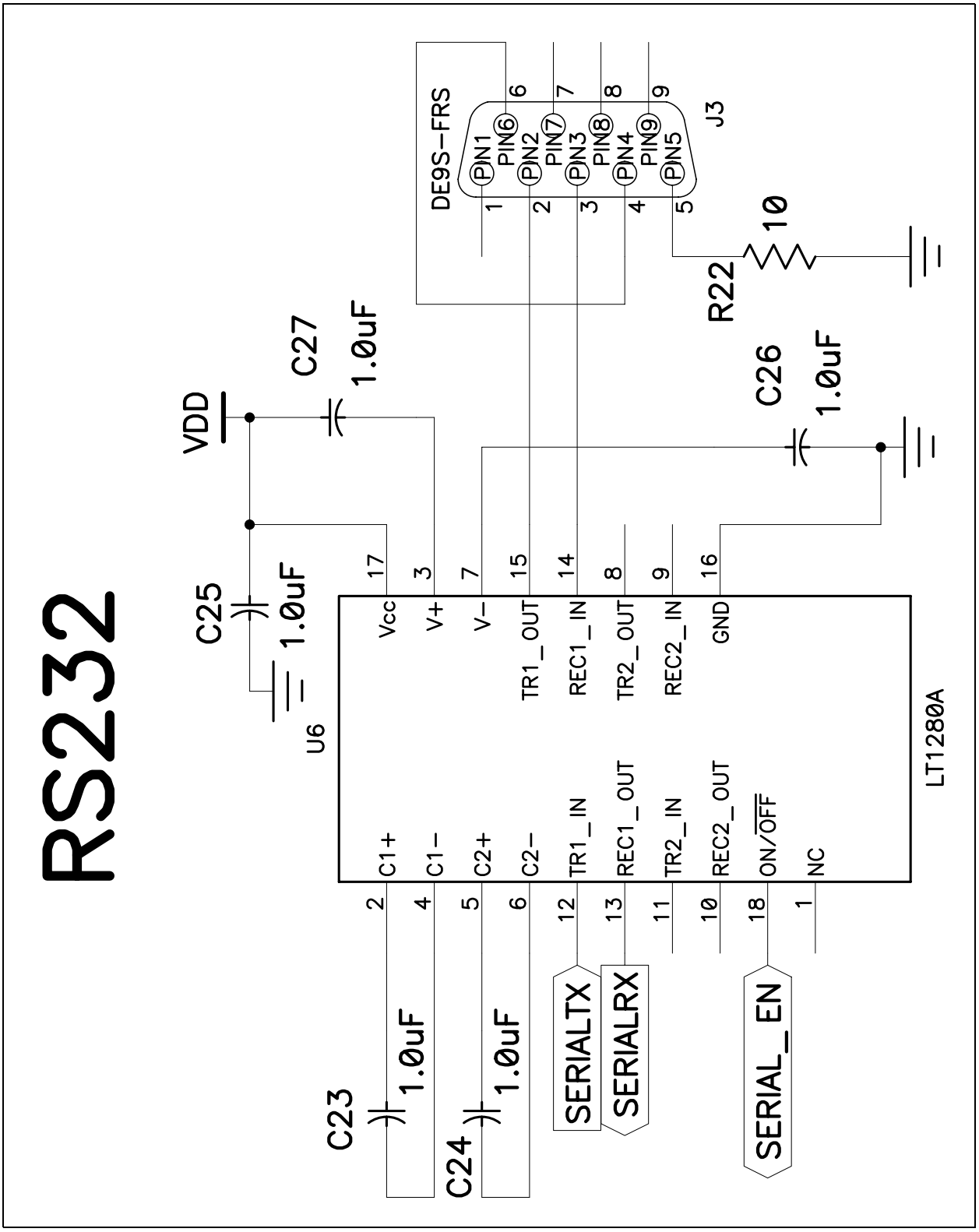


**FIGURE A-6: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 5**

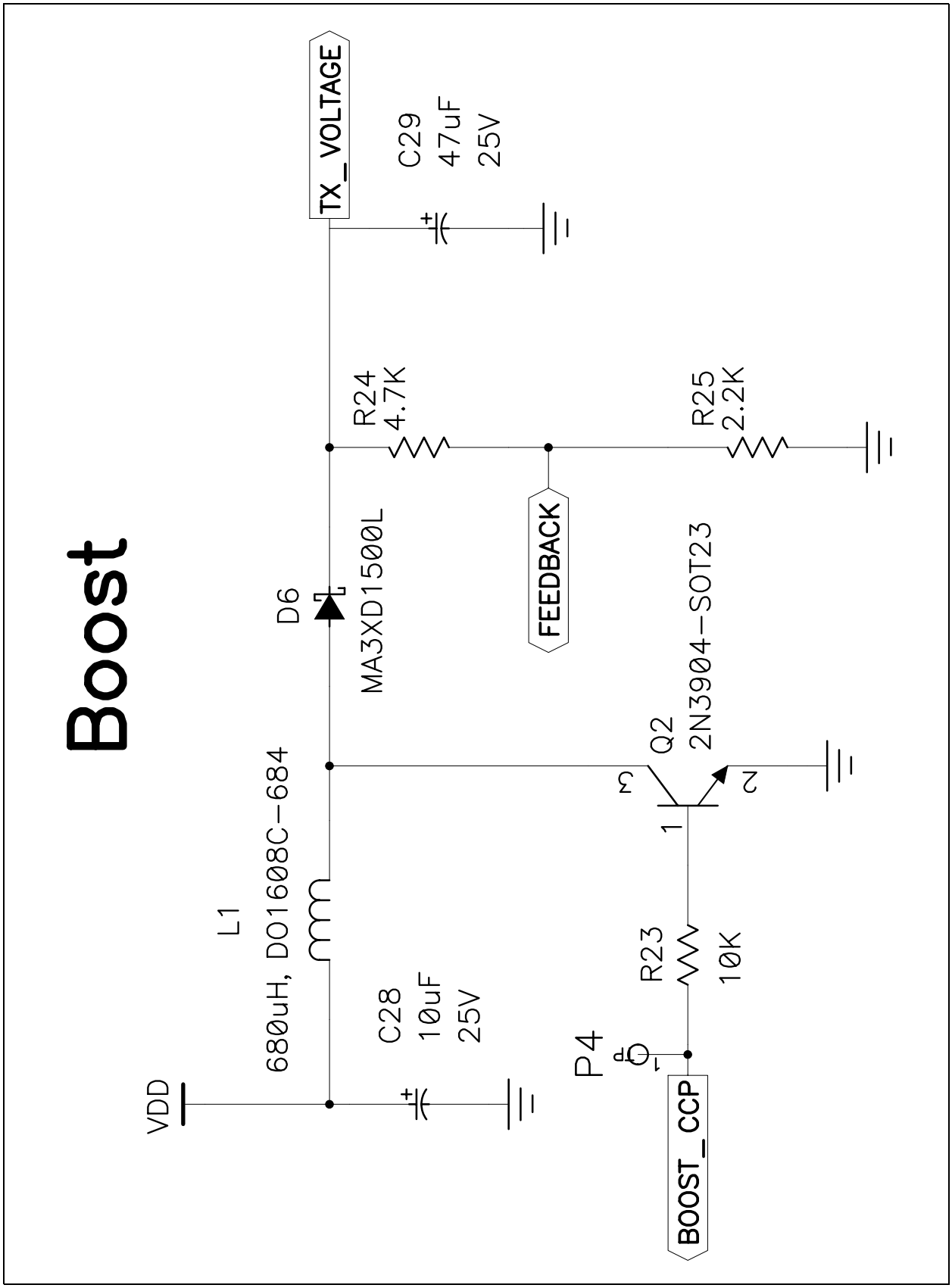


**FIGURE A-7: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 6**

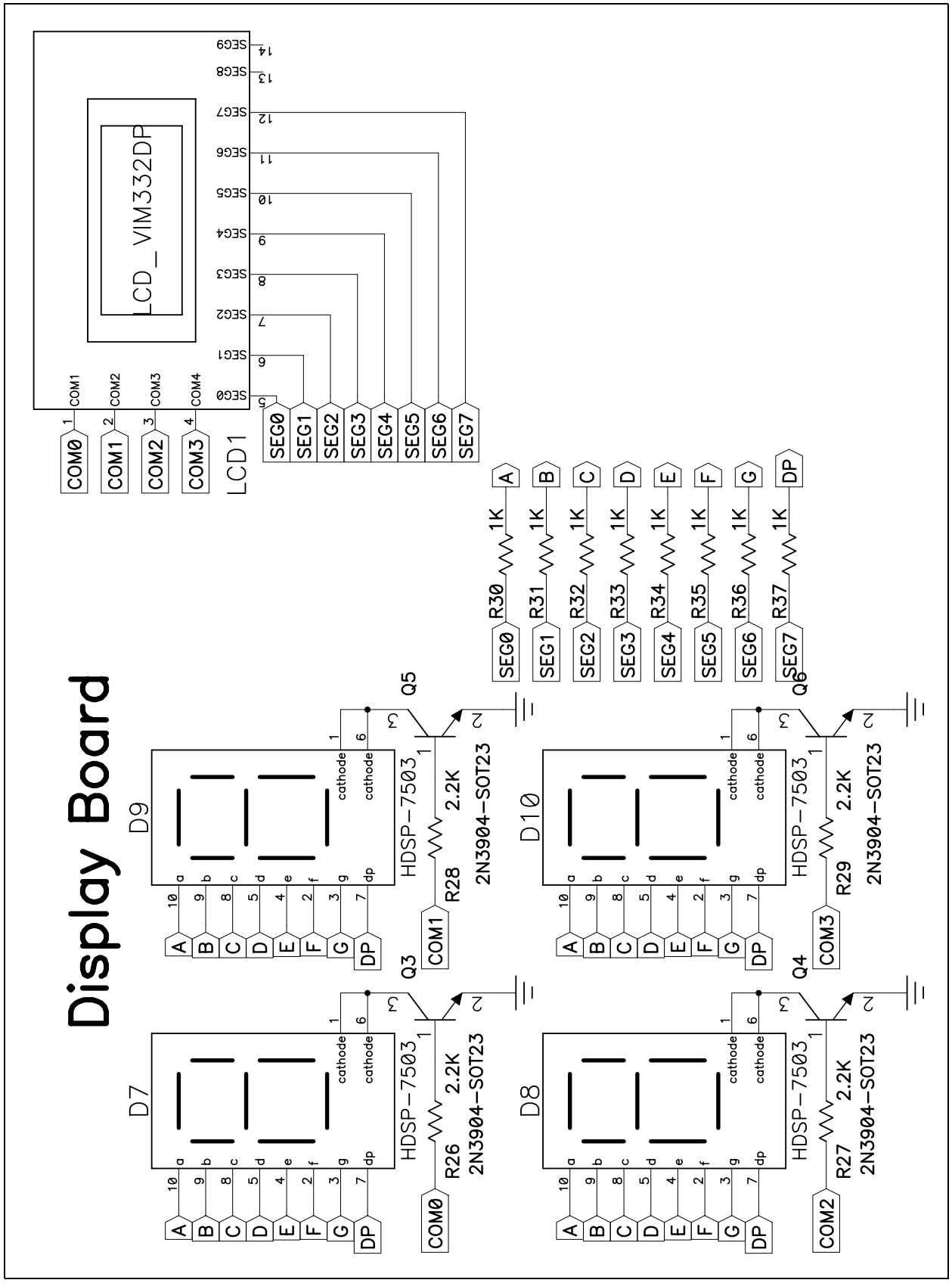
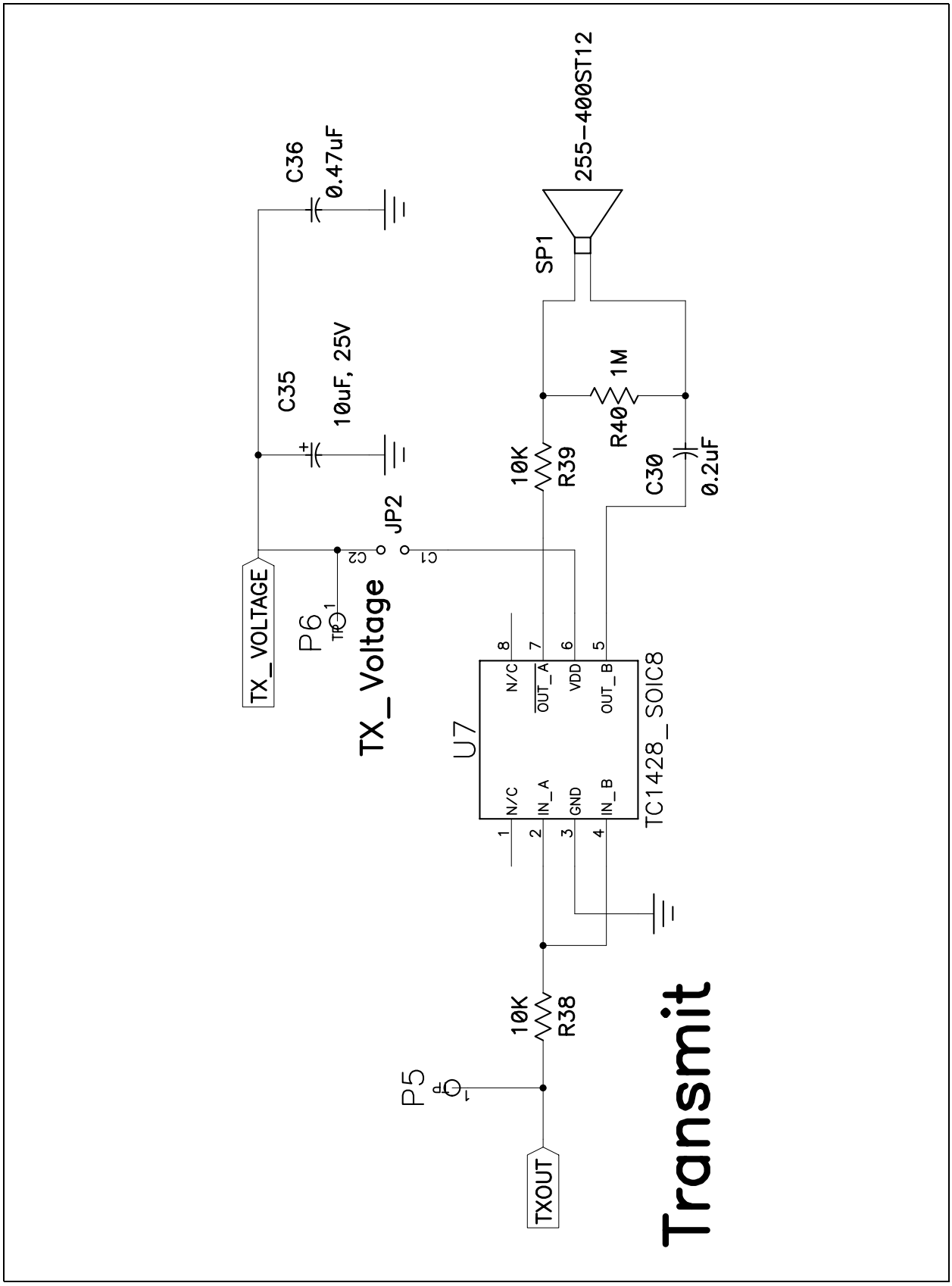


**FIGURE A-8: LOW POWER SOLUTIONS DEMO BOARD SCHEMATIC-PAGE 7**



**NOTES:**

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