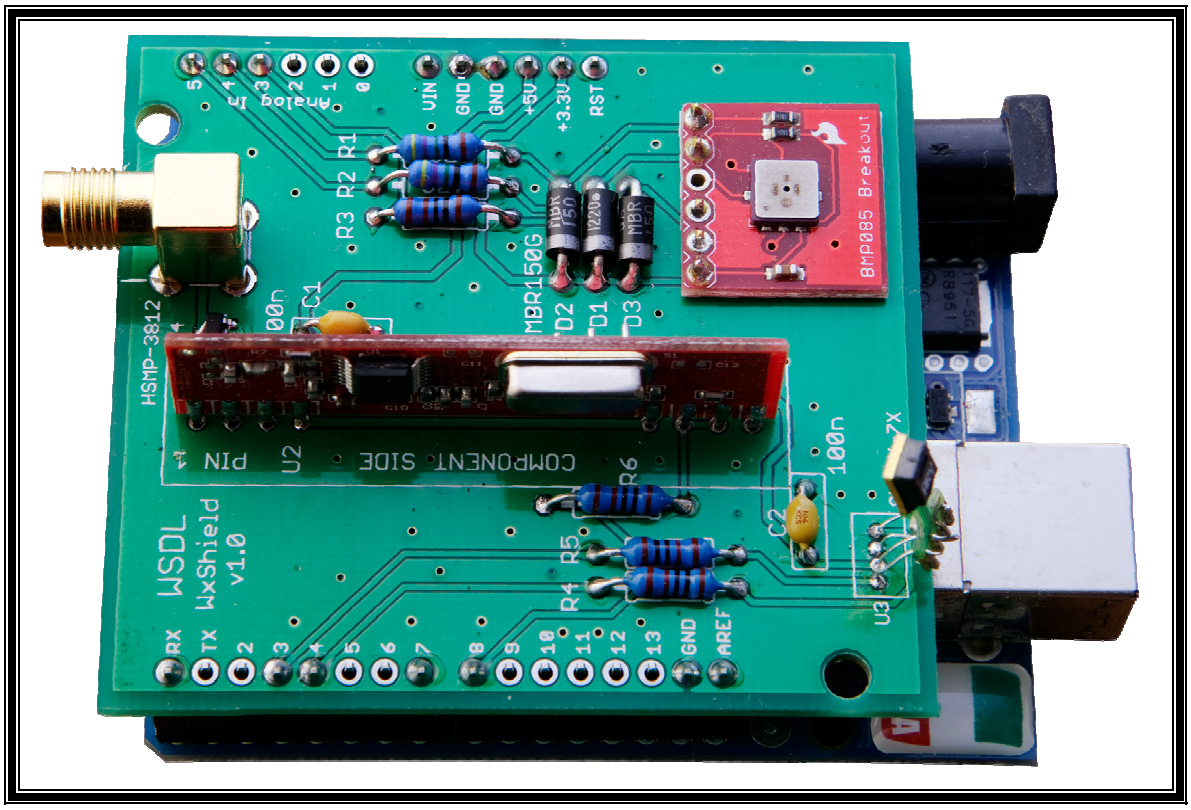
WSDL Weather Shield
for the
Arduino Uno



Version 1.1
March, 2015

2015 Update

The original receiver module is no longer available. There are at least two other modules available as of March 2015 that will work. See the section on the RF module below for details.

The Bosch BMP085 barometer is no longer available, and is replaced by the BMP180. These two parts are not completely compatible and a change to the circuit design is necessary to accommodate the newer part. A new PC board design is available for this now.

Introduction

This design is based on using an Arduino Uno board and has not been tested with other Arduino variants.

Read the rest of this document to get a feeling for what is required to build the shield board. It is recommended that you have at least a small amount of prior experience with soldering and electronics assembly, or perhaps you know someone who does and can help you out with the project.

Do read up on the dangers of electro-static discharge (ESD) and do all your work in an ESD-safe environment. Some of the parts (e.g. the 434MHz receiver module) can easily be damaged by ESD and you'll never feel the little static zap that did it. Some components (again, like the receiver module) will not just quit working when damaged by static. Instead, the performance will degrade a little bit with every "zap". The receiver module is known to become a little less sensitive every time its' RF input pin is zapped. This shield board design adds some protection diodes to the receiver module's antenna connection to eliminate this problem.

This document assumes the use of a custom PC board for the shield. It is also possible to build the shield from a prototype shield kit, but details of that exercise are left to the reader.

Tools Required

To build the shield board the following tools are needed:

- Soldering iron with a small tip. Something around 0.030 to 0.050 inch (0.7 to 1.3mm) is a good size.

- Small diameter electronic solder, somewher between 0.015 and 0.030 inch (0.4 to 0.8mm) is a good choice. It is much easier to apply the proper amount of solder with the smaller diameters. Eutectic solder is also recommended (SN63/PB37) as this mixture melts at a lower

temperature and solidifies smoothly after being melted. The author has no experience with non-leaded solders and cannot make any recommendations for those wanting to be RoHS compliant.

- Tweezers, small needle-nose pliers, small wire cutters (diagonal cutting pliers).
- Some 22 to 26-gauge bare copper wire ("bus wire").
- An ESD-safe work area.

The Schematic

The schematic diagram on the next page shows how all the parts are to be connected together. The receiver module, BMP180 barometer breakout board, and SHT75 sensor are all drawn as rectangles. Pins on these items are labeled identically to what is actually printed on the physical parts. The schematic will be more useful to those not using the custom PC board.

If you are not familiar with all the symbols in the schematic, ask an experienced friend to help out.

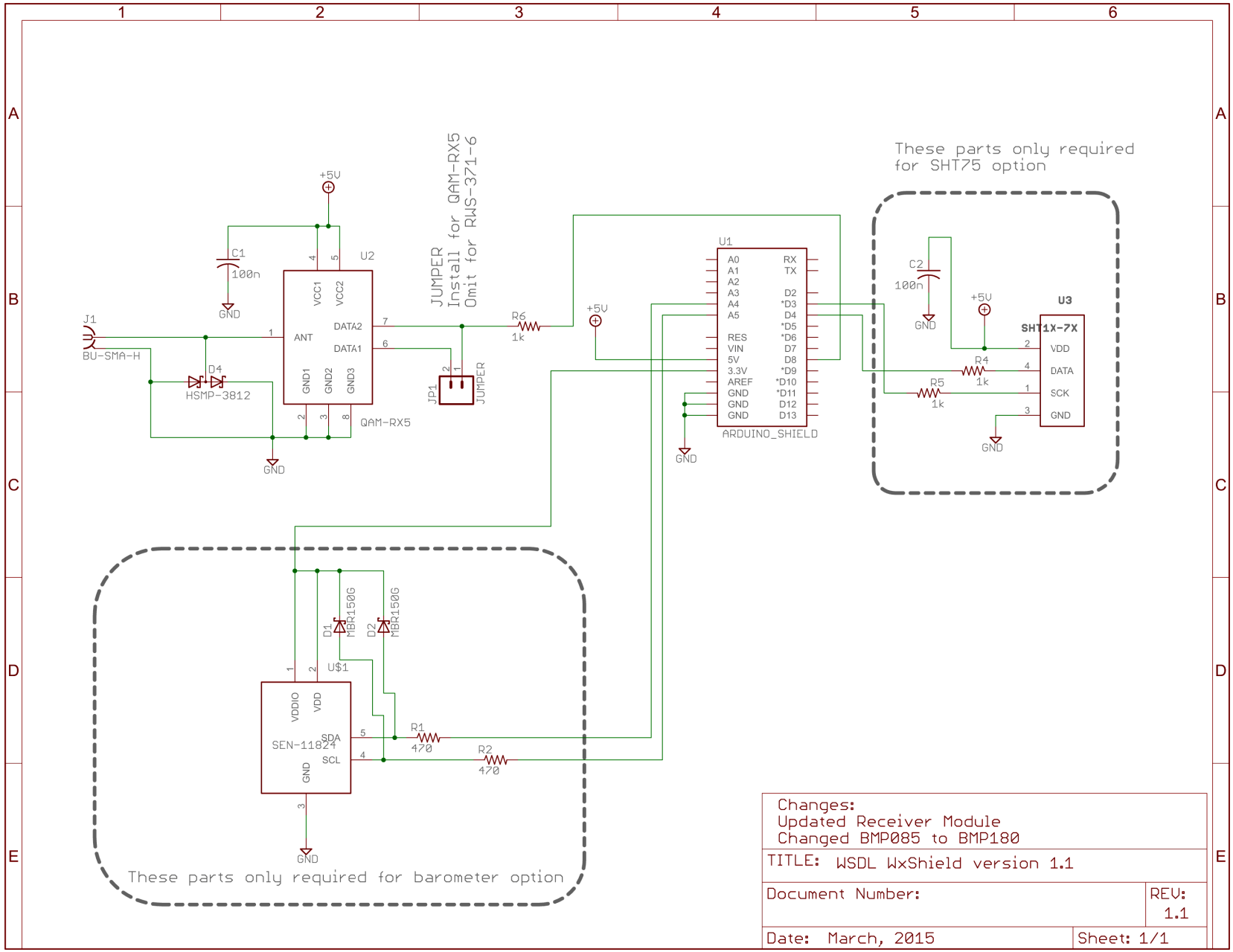
This remainder of this section explains the design of the shield board and can be skipped if you are only interested in building the shield and not how it works.

The SHT75 and receiver module can run from +5V and no logic level translation is required. The BMP085 runs on 3.3V and does require translation.

Series resistors are used on the data lines to the SHT75 and receiver module to limit current if a bus contention occurs. The value of these is not critical – anything from 1-2k ohms should work fine. The SHT75 runs without problem at a 400kHz clock rate using 1.5k resistors.

Logic level translation for the BMP180 is done with series resistors and schottky diodes which clamp the BMP180 lines to the 3.3V supply voltage. The series resistors need to be smaller than the normal 1-2k. The BMP180's I2C bus is an open-collector bus with pull-up resistors to the 3.3V supply (4.7k pull-ups are included on the breakout board). Due to the size of these pull-up resistors, R1 and R2 must be smaller (around 500 ohms) so that Arduino can pull the voltage low enough to qualify as a logic "0". The connection labeled "SJ1" on the breakout board must be shorted on both sides to the middle to activate the pullup resistors.

Although all of the breakout boards and modules include some amount of power supply bypassing, more has been added on the shield board. Perhaps this is not completely necessary, but a little more won't hurt.


1
2
3
4
5
6
A
B
C
D
E
JUMPER
Install for QAM-RX5
Omit for RWS-371-6
These parts only required
for SHT75 option
+5V
C1
100n
GND
U2
VCC1
VCC2
ANT
DATA2
DATA1
GND1
GND2
GND3
QAM-RX5
J1
BU-SMA-H
D4
HSMP-3812
JP1
JUMPER
R6
1k
U1
A0
A1
A2
A3
A4
A5
RES
VIN
5V
3.3V
AREF
GND
GND
GND
RX
TX
D2
*D3
D4
*D5
*D6
D7
D8
*D9
*D10
*D11
D12
D13
ARDUINO_SHIELD
C2
100n
U3
SHT1X-7X
VDD
DATA
SCK
GND
R4
1k
R5
1k
D1
MBR150G
D2
MBR150G
U$1
VDDIO
VDD
SDA
SCL
GND
SEN-11824
R1
470
R2
470
These parts only required for barometer option
Changes:
Updated Receiver Module
Changed BMP085 to BMP180
TITLE: WSDL WxShield version 1.1
Document Number:
REV: 1.1
Date: March, 2015
Sheet: 1/1

General Comments

The receiver module's antenna input is probably not protected from static electricity discharge. This connection is extremely sensitive and will be damaged from even the slightest static charge. It is strongly recommended to install the receiver module onto the PC board last -- after the HSMP-3812 protection diode is in place. If not using a custom PC board, the protection diode can be soldered directly onto the receiver module itself.

After installing all components, be sure to double, triple and quadruple-check all components for proper installation (e.g. not backwards, up-side down, etc) before applying power to the shield.

To build the WxShield sketch, get the latest copy from the osengr.org web site. Find the "WxReceiverConfig.h" and make sure the WX_SHIELD_VERSION number is set to "1". There are three optional settings to detect PSM (OS SL-109H and AcuRite temperature sensors), VN1TX (AcuRite 5n1) and WXSENSOR signals. Set all of these to zero unless you need to receive these optional signals. At this point the sketch can be uploaded to the Arduino board.

Load the WxShield sketch into the Arduino board BEFORE installing the shield onto the Arduino. Remove power from Arduino while installing the shield.

SHT75

This temperature/humidity sensor is optional, and parts R4,R5,C2,U3 can be omitted if desired. You can also use one of the less accurate variants such as the SHT71.

It is worth noting that soldering this sensor directly to the shield PC board will cause it to read a higher temperature (by several degrees C) because the Arduino board dissipates power when running and will be warmer than the ambient air. To get an accurate temperature reading, the SHT sensor should be installed at the end or a short cable (e.g. 1 to 3 feet) between the PC board and sensor.

BMP180

Some square pin headers were used to mount the breakout board as shown, but bare bus wire would work just as well. Be sure to mount the breakout with the barometer part UP, not down against the shield board.

This is also optional and parts R1,R2,D1,D2,U4 may be omitted if desired.

Receiver module

The PC board is intended for use with the QAM-RX5 module from RF Solutions. This is available at Digikey. When using this module, a short piece of bare copper wire bent in a "U" shape should be installed in the jumper "JP1" holes to short them together.

There is also the Wenshing RWS-371 module from SparkFun which has a slightly different pin arrangement. This one can be made to work if it is installed backwards (e.g., install pin 8 in the pin 1 location on the PC board), and if pin 3 (pin 6 as numbered on the PC board) is cut. In this case, do not install the jumper in the "JP1" location. The pin names are printed on the PC board, so be sure to double-check against the module's data sheet when installing.

Parts list

Some part numbers for Mouser are included, but these are available pretty much anywhere (e.g. Digikey, Newark, and many other places too numerous to mention). The boards/modules from SparkFun may also available elsewhere. This is not meant to be an endorsement for Mouser or SparkFun or any other parts distributor; please use whatever supplier you are comfortable with.

The total price is going to be somewhere around $120-130 plus shipping and taxes. Tack on another $20 or so if you want the SMA connector on the board with a cable/adapters to type-F CATV coax.

I usually order a few extra of the cheaper items (diodes, resistors, capacitors) in case I ruin one of them.

The SHT75 sensor is really an SHT15 sensor mounted on a thin PC board by Sensirion. The thin PCB is nice because it thermally isolates the sensor. This is what is used in the photos.

1 ea, Arduino Uno board ($30)

1 ea, Custom Shield board ($2.20 ***)

1 ea, 433.92MHz receiver module, RF Solutions QAM-RX5 or Wenshing RWS-371 ($5-$8)

1 ea, Bosch BMP180 breakout board (optional)
SparkFun SEN-11824, ($10)

1ea, Sensirion SHT75 sensor (optional)
Newark 18M2988 ($36)

1 ea, Avago HSMP-3812 PIN diode array
Mouser 630-HSMP-3812-TR1G ($1) ea

2 ea, BAT48 schottky diodes (required for barometer option)
Mouser 511-BAT48 ($1)

3 ea 1k ohm 1/8 watt resistors
Mouser 71-RN55D-F-1.0K, ($1)

2 ea 499 ohm 1/16 or 1/8 watt resistors (required for barometer option)
Mouser 71-RN55D-F-499 ($1)

2 ea 100nF/10V (or more) axial lead ceramic capacitors
Mouser 581-SA115C104KAR ($1)

1ea, SMA right angle connector, TE Connectivity 5-1814400-1
Stocked at both Mouser and Digikey ($3)

1ea Dipole antenna with 15-foot cable and SMA connector, Linx Technologies ANT-433-MHW-SMA-L, Mouser 712-ANT-433-MHW-SMAL ($12)

Total approximate cost is then as follows:

- Receiver module only: $58
- Add barometer for another $10
- Add SHT75 for another $36

*** Pricing on PC boards is per board from Seeed Studio at $22 for ten boards. This assumes that 10 boards are purchased and shared amongst ten WxShield projects. Add another $20 to the project cost if the PC boards are not shared.