Programming for
The Dinsmore R1655
Compass Module

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The first choice you have is to determine the resolution you wish to have. In this write up, a resolution of 0.1 degrees was chosen. Thus, a 12 bit Analog to Digital converter was used. The specific part number is an LTC-1258 although if you apply the rules, any A/D will do just fine.

In a 12 bit A/D, the maximum voltage that can be represented is 5.000 volts. 5.000 volts is represented by the maximum number of bits which is 4096. Thus if we divide 5.000 volts by 4096, we find that each of the 4096 bits has a value of 0.001220703 volts. For our calculations, .00122 is just fine.

The R1655 comes with a graph that shows us the output values of the "A-Lead" and the "B-Lead". First, we start with the place where the A-Lead and B-Lead cross and are equal to each other and above the middle point of 2.5 volts. 2.5 volts is half of our 4096 bits or a value of 2048. On the chart, the value shown is 2.86 volts for the A-Lead and 2.91 volts for the B-Lead. To determine the exact crossing point it is 2.91-2.86 = 0.05. Thus, 2.86+ 0.025 = 2.885. Since we will add an auto-calibration feature, we will round down to 2.882 volts as our working base point. A bit number of 2361 represents the 2.882 volts divided by .00122.

Now we do the same for where the A-Lead and B-Lead cross below the 2.5-volt or 2048 bit point. The chart shows 2.13 volts for the A-Lead and 2.07 volts for the B-Lead. Doing the above math again, we get that the lower cross point is the 1721 bit point.

Here's the trick. Let's say that on the left of our chart where the A-Lead and B-lead cross above the middle point is zero degrees and is our starting point for our compass. During the time, the B-Lead is at or about the 2361 crossing point, the A-Lead value is telling us the angle! Next, we see the A-Lead going below our lower crossing point of 1721 and the A-Lead is telling us our angle. Next, we see the B-Lead is below the lower crossing point, and while it is, the A-Lead now tells us the angle. Lastly, the A-lead now goes above the 2361 cross point so we end up with B-Lead above 2.88 (2361) for 0-90 degrees, A-Lead below 2.10 (1721) for 91-180 degrees, B-Lead below 2.10 (1721) for 181 to 270 degrees and B-Lead above 2.88 (2361) for 270-360 degrees.

Our last needed number is the range between the upper cross point and the lower cross point. 2.88 – 2.10 (2361 – 1721) gives us a 0.78-volt (or 640-bit) spread. This spread represents the 90 degrees in each of the four sections so if we divide 90 degrees by either 0.78 (or 640) we now know the voltage or bit change per degree.

The largest number we can use in a PIC is 65,535. Therefore, our calculations must become a bit "creative" so we don't exceed this limit. At the same time, accuracy depends on larger numbers. In the program there is a variable called scale. Scale is 90000 (90 degrees) divided by the 640 we got from the upper cross point value – lower cross point value. So we can work with a smaller number, the value of 140 is reduced to 35.

Okay, now the part you've been waiting for, The formulas!

Section A (0-90 degrees):

RawCompass = (UpLimit – A_Curve) * Scale

The raw compass reading equals the Upper Cross-Point minus the value we read from the A-Lead times the scale factor.

Compass = ((Raw Compass/10) * 4) /10

The actual compass reading. We divide the large number by 10, the scale number was originally divided by 4 so we must multiply by 4 here, then divide the whole thing by 10.

Section B (270-360 degrees):

RawCompass = (B_Curve – LowLimit) * Scale
Compass = ((Raw Compass/10) * 4) /10

CrossZero = Compass + 2700
We are working in the 270-360 area and the B_Lead will give a value from 0-90 degrees. Therefore, we must add 2700 (270 degrees). Remember, we are looking for 0.1 degree display.

If CrossZero >= 3600 then Section BA
If we get a value of 3600 (360 degrees) or more then we must subtract 3600 from the reading.

Section C (90-180 degrees)

RawCompass = (UpLimit – B_Curve) * Scale

Compass = ((Raw Compass/10) * 4) /10

CompDisp = Compass + 900
We are working in the 90-180 area and the B_Lead will give a value from 0-90 degrees. Therefore, we must add 900 (90 degrees).

Section D (180-270 degrees):

RawCompass = (A_Curve – LowLimit) * Scale
Compass = ((Raw Compass/10) * 4) /10

CompDisp = Compass + 1800

Calibration:

In case of a variation in our 5-volt supply and since we really did not start with super accurate cross point, this we re-calibrate our numbers for increased accuracy.

If A_Curve > 2048 then UpLimit = A_Curve

If the reading of the curves is more than the mid-point of 2.5 volts (2048 bits) then we are looking at the upper cross point.

If A_Curve < 2048 then LowLimit = A_Curve

If the reading of the curves is less than the mid-point of 2.5 volts (2048 bits) then we are looking at the lower cross point.

Spread = 9000 / (UpLimit - LowLimit)

90 degrees divided by the difference of the upper and lower cross points.

Scale = (Spread * 10) / 4

Our new scale number. We started with 35, now we have more accurate values to work with so we mine as well include the scale factor.

That's about it. The rest of the program has to do with communication with the A/D and whatever display you are using.