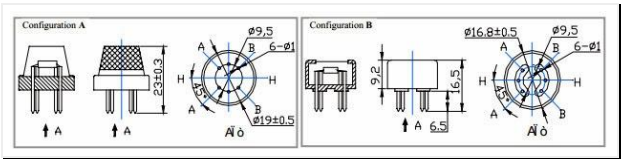
Davide Gironi

Saturday, January 25, 2014

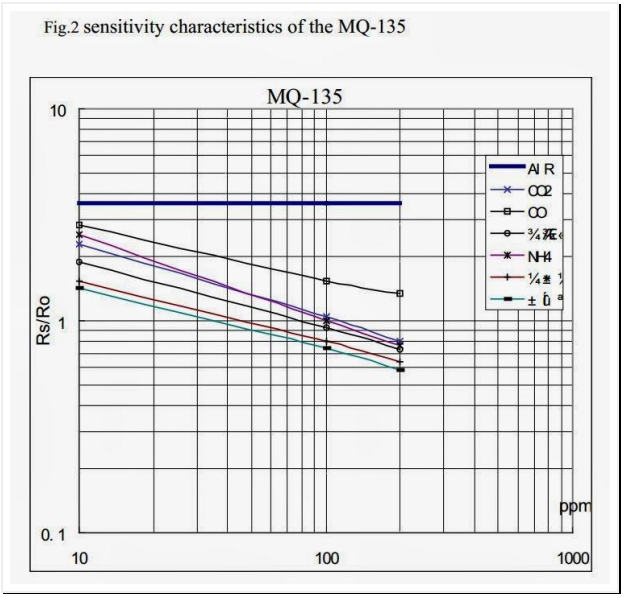
Cheap CO2 meter using the MQ135 sensor with AVR ATmega

MQ135 is an **Air Quality Sensor** suitable for detecting of NH3, Alcohol, Benzene and other gases.



The description below, is what i derive from the poor datasheet of this sensor, it may be uncorrect, so if you have suggestions please leave me a feedback.

The "*sensitivity characteristics of the MQ-135*" figure of the datasheet, you can see it below, it is used to convert the output of the sensor to the related ppm physical physical charateristic for the gas under test.



The graphic above seems a power function
*y = a*x^b*
so
ppm = a(Rs/Ro)^b*
using power regression, we can obtain scaling factor (a), and exponent (b), for the gas we would like to measure

Then
*Ro = Rs * sqrt(a/ppm, b) = Rs * exp(ln(a/ppm) / b)*

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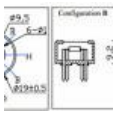

Cheap CO2 meter using the MQ135 sensor with AVR ATmega

So, if we want to calibrate a sensor, we "just" need a know amount of a certain gas, then we can read the resistance output value from the sensor (Rs), and we can compute the calibrated Ro value.
We know the current amount of **CO2 gas in atmosphere** http://co2now.org/, we can use this as a reference for calibration.

Datasheet tell us even detecting concentration scope for a certain gas, so we can compute the limit for Rs/Ro.

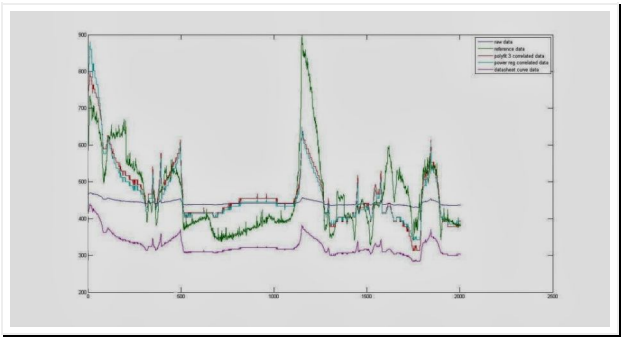
Rs/Ro_limit = (ppm/a) ^ (1/b)

Now, because i want to build a CO2 meter, let's try to calibrate this sensor for measure CO2.

For CO2, if we measure points graph and do power regression we can obtain the function
ppm = 116.6020682 (Rs/Ro)^-2.769034857
we also know that the current amount of CO2 gas in atmosphere is (unfortunately) 392ppm, so, heating the sensor for 24 hours, and leaving it in open air, if we measure 26954ohm as the resistance output we can Ro should be 41763.
Datasheet does not tell us much for detecting concentration scope for this gas, the figure is from 0.1 to 100ppm, but we can suppose a limit from 10 to 2000ppm.

The above derivation seems to works quite well, but for estimating the scaling factor, and exponent in a more precise way, i've logged raw adc data from MQ135 and correlated to a MHZ14 NDIR infrared sensor.

Data was logged on a xively datastream.



You can see the correlation results above.
Correlation is done by a matlab script using power regression and polynomial curve fitting.
We have to convert raw value to calculated resistance.
And then, because we will later use a Ro, we "impose" a arbitrary Ro, such that scaling factor and exponent can be used in the math of our microcontroller.
Imposing a Ro of 41000, obtained scaling factor in my experiment is: 56.0820, and exponent is -5.9603.
Using this parameters now we should obtain a better response for our sensor.
The Ro calibration is again important because one sensor can differ from other.
The previous reading of 26954ohm return, using those new correlated scaling factor and exponet values, us a value of 683ppm, without any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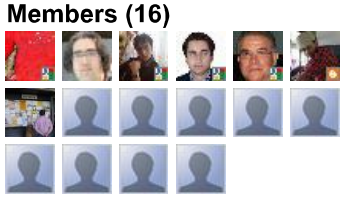

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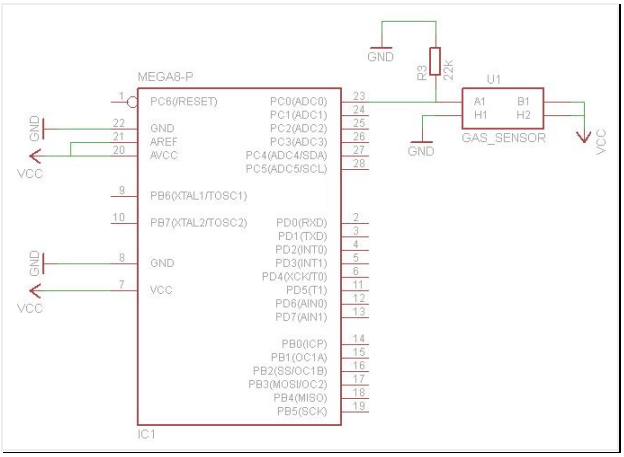
calibration of the Ro.

I've checked the xively datastream with the new correlated function, and it seams to repond a little better than the datasheet one, even if reading does not always respond as is expected.

I've checked this method against 5 sensors, 4 of them, after the Ro has been calibrated, seems to fit the same response curve, 1 not. Because MQ135 are electro-chemical sensor, i do not expect all the sensors has the same curve.

With the code you can find the **matlab script**, and the **speadsheet helper** for computations.



ChangeLog

- 01b: fixed inconsistent value of the R3 resistor between schematics and code (thanks to *Emmanuel Pierre* for reporting this bug)
- 01: first version.

Code

- avr_lib_mq135_01b.zip
- ~~avr_lib_mq135_01.zip~~

Notes

- read risk disclaimer
- excuse my bad english

Pubblicato da Davide Gironi a 6:25 PM
Etichette: atmel eletronic
Ubicazione: Milano, Italia

22 comments:

Chris Fredriksson February 20, 2014 at 7:32 PM

The chance for getting this to work is possibly quite high then? Compared to other CO2 sensors, this makes a really cheap variant so it would be awesome for DIY :) I've ordered some MQ-135 to see if I can get it to work as well!

Reply

Replies

Davide Gironi February 20, 2014 at 8:50 PM

yes, but keep in mind that 1 of the 5 sensor i've got has a different behaviour of the other.
so the calibration curve is different, and you can not use the one i've proposed here.

Reply

Chris Fredriksson February 20, 2014 at 7:37 PM

By the way, you dont happen to have any video with the testing of this project? Blowing on it and showing some values from the UART? As I can't test this myself right now, it would be awesome to see it working on video :)

Reply

Replies

Davide Gironi February 20, 2014 at 8:51 PM

no video of this project unfortunately.

Reply

Akshai March 16, 2014 at 4:38 AM

Unfortunately my multimeter detects the connection between H1 and H2 to be short circuit (shows a resistance of 30 Ohm which is very low) , hence when i connect this to my arduino voltage across USB drops to 3.6 V across the terminals and I am unable to run a 2*16 LCD display.The current drawn by the sensor is about 150 mA.What should be done ? Should I connect a 100 ohm resistor in series with the coil to limit current.Will that affect readings too much ? or should I use an external voltage regulator IC to drive the sensor ?

Reply

Replies

Davide Gironi March 16, 2014 at 1:40 PM

hello,
H1-H2 resistance is correct, this a chemical sensor with an heating element, H1-2 does the heating, that's the reason why it sucks 150mA.
Connect the sensor as the circuit you find above. Use and external power supply if you pc can not supply enough current to run all your devices. Double check your wiring, keep in mind that with an external supply you can eventually damage your USB connection port.
You can also use an external powered USB hub, this is what i usually use for experiments.

Reply

I Putu Gede Bayu Wisnawa March 25, 2014 at 10:34 AM

hello do you can show u'e code ?

Reply

Replies

Davide Gironi March 25, 2014 at 12:24 PM

you can find code in the link above, in the post.

Reply

fungky king March 30, 2014 at 3:34 PM

Hallo,
can you help me.
if the MQ135 use for Alcohol meter, how about calculate conversion formula?
i'm applying with C code.

Reply

Replies

Davide Gironi March 31, 2014 at 10:13 AM

Apply power regression to "sensitivity characteristics of the MQ-135" figure of the datasheet, searching for alchool points.

Reply

I Putu Gede Bayu Wisnawa April 1, 2014 at 4:33 AM

hy mr. I use this code as an example of my project, what do you think?
whether the Rs output is listed ppm?

```
int adcPin = 0;
int adcValue = 0;
float v;
float rs, ppm;
void setup ()
{
Serial.begin (9600);
delay (2000);
}
void loop ()
{
adcValue = analogRead (adcPin);
v = adcValue * (5.00/1024);
rs = (100 - (20.00 * v)) / v;
Serial.print ("Volt out put");
Serial.println (v);
Serial.print ("RS =");
Serial.println (rs);
delay (1000);
}
```

Reply

Replies

Davide Gironi April 1, 2014 at 12:55 PM

To me the sensitivity characteristic curve to convert the reading from the sensor to ppm, found in the datasheet, seems a power function, and your Rs conversion is not power.
Also i do not find any voltage to ppm reference in datasheet, this is the reason why i convert ADC to resistence value. You can also use voltage for conversion of course, it depends on your conversion function.

I Putu Gede Bayu Wisnawa April 1, 2014 at 4:49 PM

so, the output of the code does not display the data to ppm?
because there are 2 outputs. The first output of the voltage, and a second output Rs, so now I'm confused. how to display data in the form of ppm, I've read its datasheet, but I do not understand to implement to the Arduino.

whether you could help me?

Davide Gironi April 1, 2014 at 6:15 PM

yes, the first is the voltage.
you have to relate the value read from the sensor to the ppm value of the gas.
if you read my post above, you can find the description and methods to convert it to ppm.
in this post you can also find code that compute this conversion.
in a few word.. convert ADC value to resistence, then use the "sensitivity characteristics of the MQ-135" figure of the datasheet, to correlate it to ppm, finding the power regression curve that fits this conversion.

I Putu Gede Bayu Wisnawa April 2, 2014 at 3:30 AM

ok I'll try, thanks for the explanation

I Putu Gede Bayu Wisnawa April 18, 2014 at 4:39 AM

helow this is my poject http://www.youtube.com/watch?v=GA2juXog7NY i"m useng Sensor Mq123 for CO2 ditection, but valibration sensor inaccurate.

I do not understand how to translate the formula in the datasheet to get the output ppm, bisakh you give me an example of code themselves?

I built using micro controller manufacturer ATmega 328 Arduino uno.

I was progreming basic visual studio. I hope you will

help me because it is very hard so that I can complete my studies.

Davide Gironi April 18, 2014 at 11:44 AM

You can download sample code from this post, you will find it right above here, it's avr_lib_mq135_01.zip.
There you can find my way to convert MQ-135 resistance value read from ADC to ppm.

Reply

Chauhan Parag December 26, 2014 at 4:21 PM

How to find a and b ?

Reply

Replies

Davide Gironi December 26, 2014 at 5:56 PM

Hello, you have to use power regression on the datasheet curve.

Reply

Chauhan Parag December 27, 2014 at 6:12 PM

Thank you,
What is the Rs and R0 ?
How to find Rs for CO2 gas ?

Reply

Replies

Davide Gironi December 27, 2014 at 8:30 PM

You can reat this in the post above. Anyway, Rs is the resistance output value from the sensor, Ro is the calibration value used in to correlate read Rs to gas ppm. To find Rs, just read the resistance of the sensor when it is heated.

Reply

Chauhan Parag December 28, 2014 at 1:24 PM

Thank for help,
I am calibrate R0 for specific ppm of CO2 gas after set RL=R0,which can give me voltage at adc pin this voltage converted inform of percentage and display on LCD.
When ppm change,R0 is change(according you calculated),again i am set RL=R0, and process repeated.i am used RL as a potentiometer(variable resistor).

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