5hz to 500 Khz Frequency-Meter

Home-made, accurate, and simple solution!

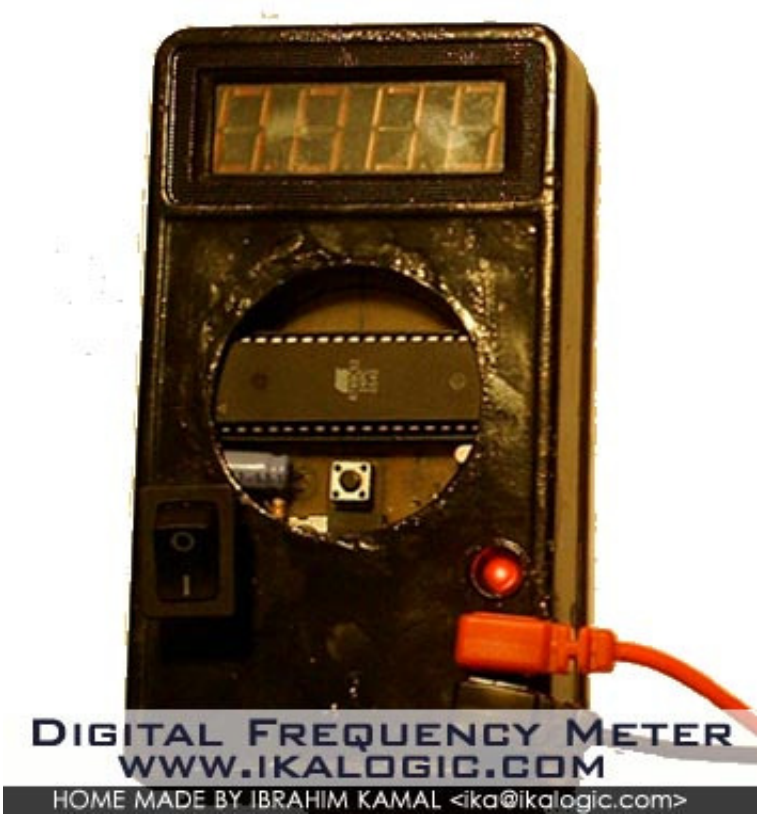
By Ibrahim Kamal

Last update: 4/4/08

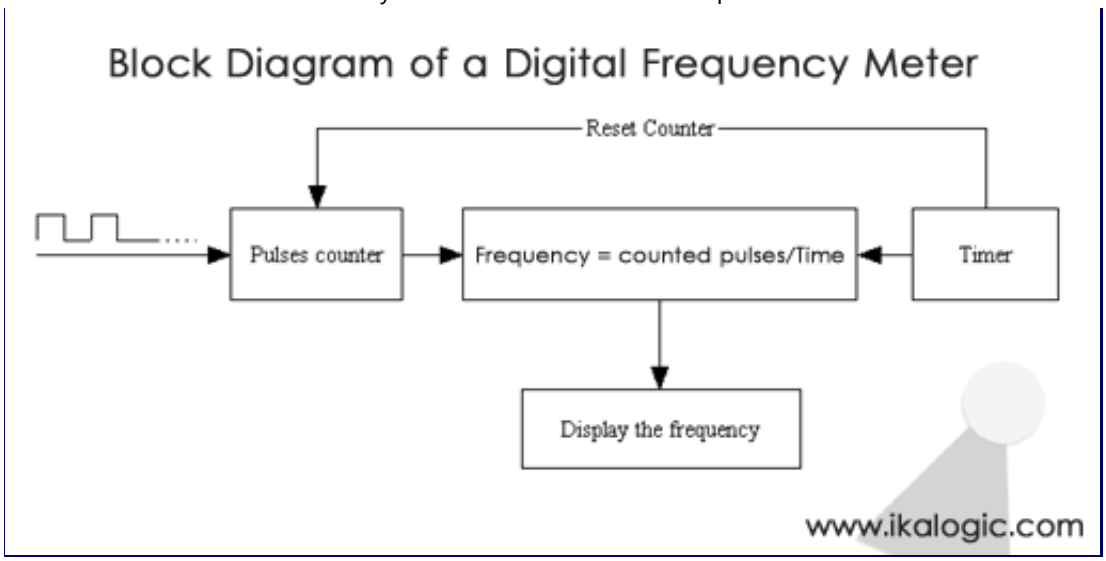
Overview

Based on the famous AT89C52 microcontroller , this 500 Khz frequency-Meter will be enough to trace and debug most of your circuits, to adjust 555 timers frequency and perform all kind of frequency measurements in Digital circuits. And once you have this tool between your hand, you will get used to it to the point of no-return! and you will say *"remember the days we adjusted the frequency by trial and error till we get it..!"*

Note: This tutorial assumes you already have some basic notions about microcontrollers and general electronics skills.



To understand the block diagram below, you should recall the simplest definition of frequency: **"the number of occurrences within a given time period".** What we are trying to do is to count the number of electric pulses during a time of one second. To do this we need a counter, to count the pulses, and a timer so that every 1000 milliseconds, the processor stop counting, calculate the frequency and display it, then start counting again from zero.



This is the principle of operation of a frequency meter, however, to build a reliable frequency meter, we will need to do some more mathematical operations. For example: Some operations will accurately predict the frequency before waiting for a whole second to elapse, which will also increase the refresh rate. Another minor upgrade is to to display the average of the last 5 reading rather than displaying the frequency instantaneously (which can cause lot of display flickering if the frequency being measured is not very stable).

This project will be discussed in two Parts, the Hardware and the Software.

PART 1: HARDWARE

The Hardware Parts

Lets start by this easy part,to make the project look far-or-less like a profession lab equipment, well I simply built it in an old Avo-Meter, one of those you find in stores for less than $5! (god bless china!), and then painted it all in black. (it was originally yellow!)

And by the way, after I hacked that poor Avo-Meter, I also used the same leads for our frequency meter.

As you can notice in the picture, there are 4 seven segments display

Finally you can also notice the 2 connections for the leads **(Blue shaded area)**. those connectors are standard for the test leads of most AVO meters and testing devices.

The Display

Before Getting into the electronics, here is a final trick:

To make the display look even neater and Protect it from dust and scratches, simply add a thin plastic film on top of it *(it will be firmly held in its place when the frequency meter is re-assembled*).

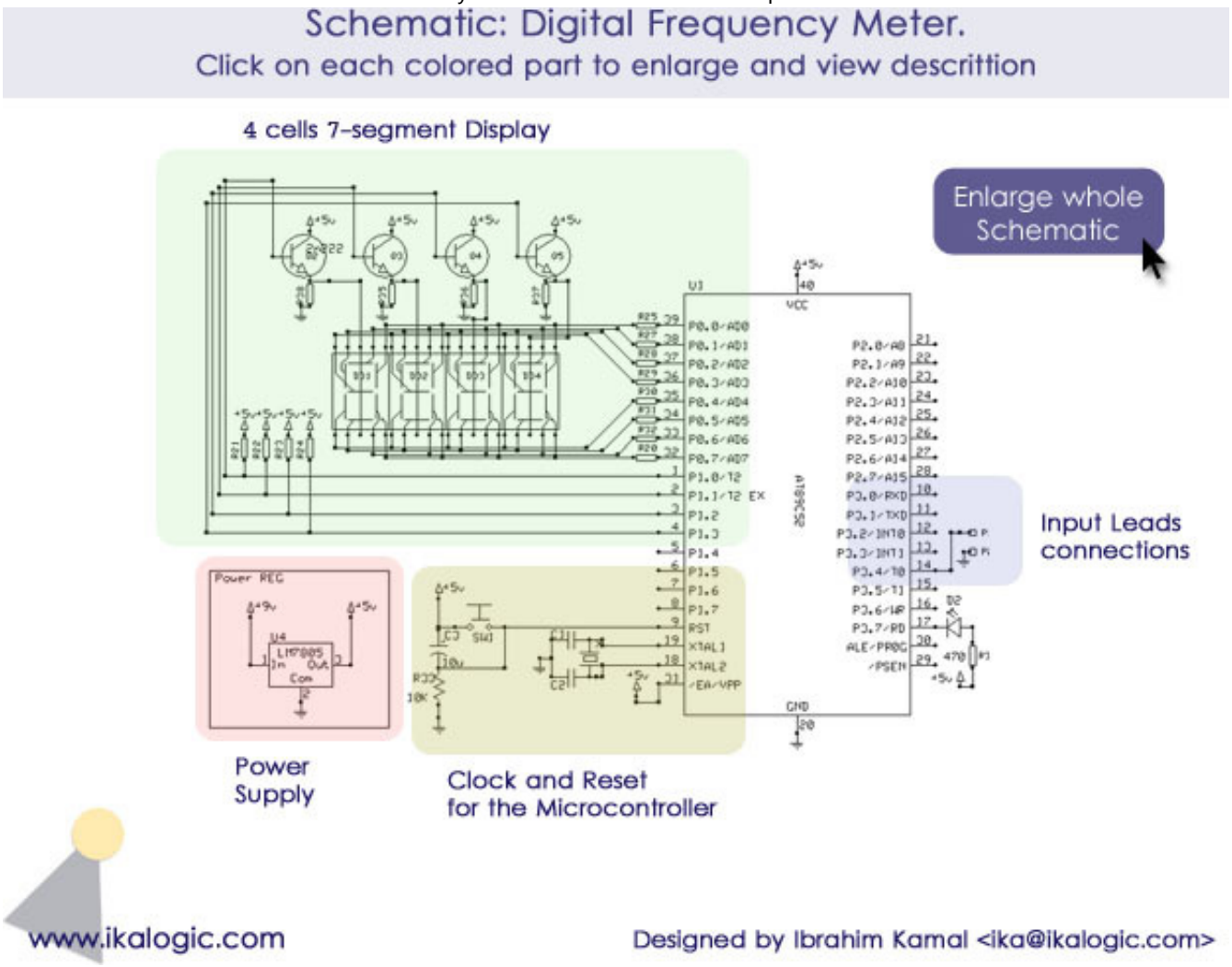
A piece of plastic film, less than 1 mm thick. preferably with a liltle shade to hide eventual defects beneath it

The 7 Segments Displays without the Protective Plastic Layer

Notice How the seperations between each 7-segments cell and the other are less visible with the Shaded Plastic Layer

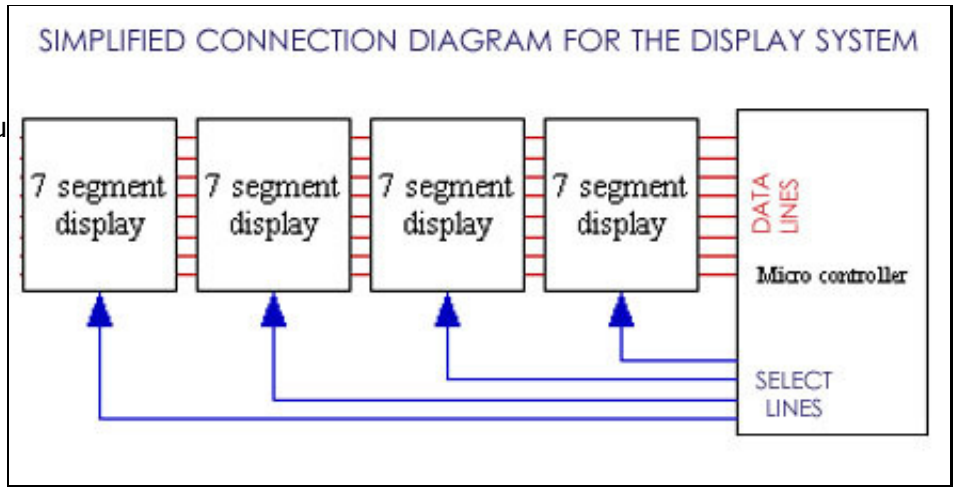
The electronics

I am sure that you understand that to accomplish this project, we will need to perform some mathematical operations, as mentioned before, to increase the performance of the device. Thus we will rely on an AT89C52 microcontroller to perform all the required tasks in this project.



■ The Display system:

While being very simple (as you can see in this diagram), the display system can seem complicated due to the high number of connections (as you can see in the schematic below).



The main idea for this display system, is to connect all the 7-segment cells together in parallel, but only power one of them in the same time.
for example, here is the sequence to show the number "1984":

1-Send the number "1" though the data lines
2-Energize the first cell while all other cells are off
3-wait for a short time delay (in my code i paused for 0.6 Millisecond)

4-Send the number "9" though the data lines

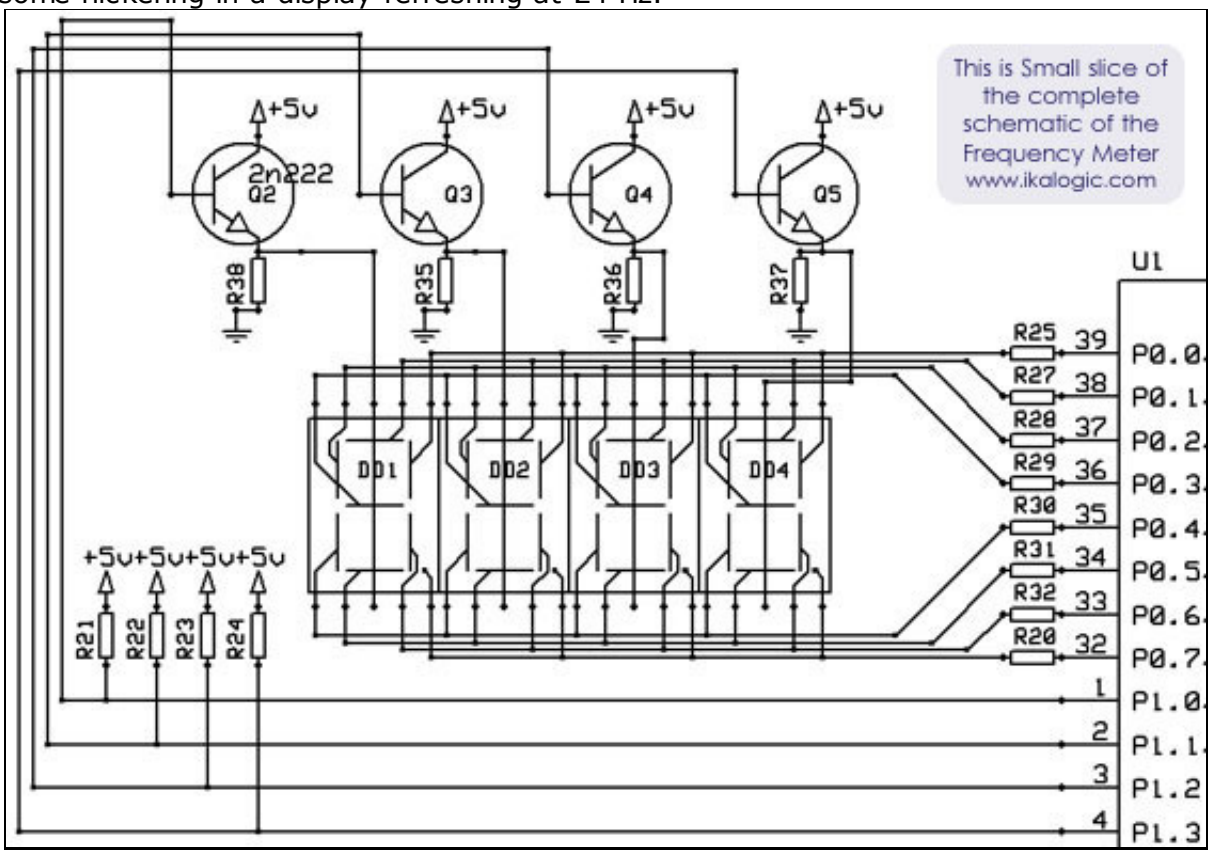
7-Send the number "8" though the data lines
8-Energize the third cell while all other cells are off
9-wait for a short time delay..

10-Send the number "4" though the data lines

5-Energize the second cell while all other cells are off
6-wait for a short time delay..
11-Energize the fourth cell while all other cells are off
12-wait for a short time delay..

13-Start over from the step No: 1.

Believe it or not, the human eye wont notice anything wrong, because, with the given delays the display will refresh at the rate of **375 cycles per second** (375 Hz!) and the human eye can hardly notice some flickering in a display refreshing at 24 Hz.



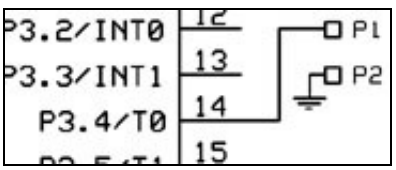
Now That you understand the display process, you should be able to easily follow the schematic above.

Here is a brief description:

Q1,Q2,Q3,Q4	2N2222 switching transistors to drive the 7-segment displays.
DD1 to DD4	7-segmets display, common Anode type. *Note that it is called 7 segments, but actually each cell contain 8 leds (7 leds for the digit, and 1 led for the decimal point)*
R21 to R24	1Kohm pull up resistors
R35 to R38	100Kohm pull down resistors
U1	The AT89C52 Micro-Controller *(actually you can only see the Port 0 and the 4 used pins of PORT 1)*

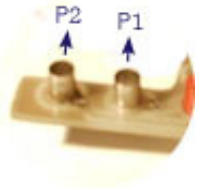
■ Input leads connections:

Nothing really critical about this part, since we only intend to measure TTL frequencies, the input is directly fed to the TO pin of the AT89C52, which will be used as a counter (more details about this in the software part).



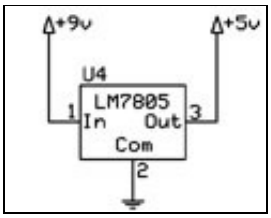
P1 and P2 are simply the 2 connections for the test leads. Note that in order to make any kind of measurements on another circuit, the ground of the Measurement device

and of the circuit being tested **must be connected together,** this is why there are at least 2 leads in any testing device (one for the Ground and one for the measured signal).



■ Power Supply, clock generator, and reset button:

The Power supply here is not critical either, because the device will be powered from a 9V alkaline battery, so we don't need any filter capacitors, we just need to reduce 9V to 5V, and this is simply the job of the IC 7805 (Usually we add decoupling and filter capacitors when there is a lot of disturbance like in motor controllers, or AC to DC power supplies)



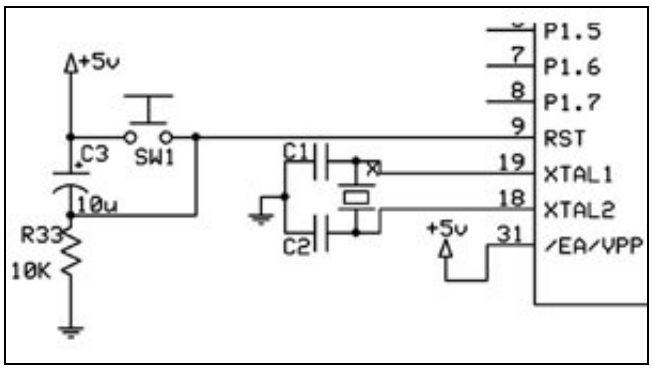
Power supply

This part is standard in any circuit containing an AT89C52.

-The switch SW1 will reset the micro-controller and start the program from the beginning.

-C1 and C2 are 27pF, any nearby value between 20 and 40 pF will work just fine.

-X is a 24 Mhz crystal. it is imperative to use a crystal of this frequency, which is the maximum frequency the AT89C52 can respond to. using a 12Mhz crystals will result in maximum measurable frequency of 250 Khz instead of 500Khz. Don't forget to connect the PIN 31 to the 5V, otherwise the microcontroller wont work.



Clock generation, and reset button

PART 2: SOFTWARE

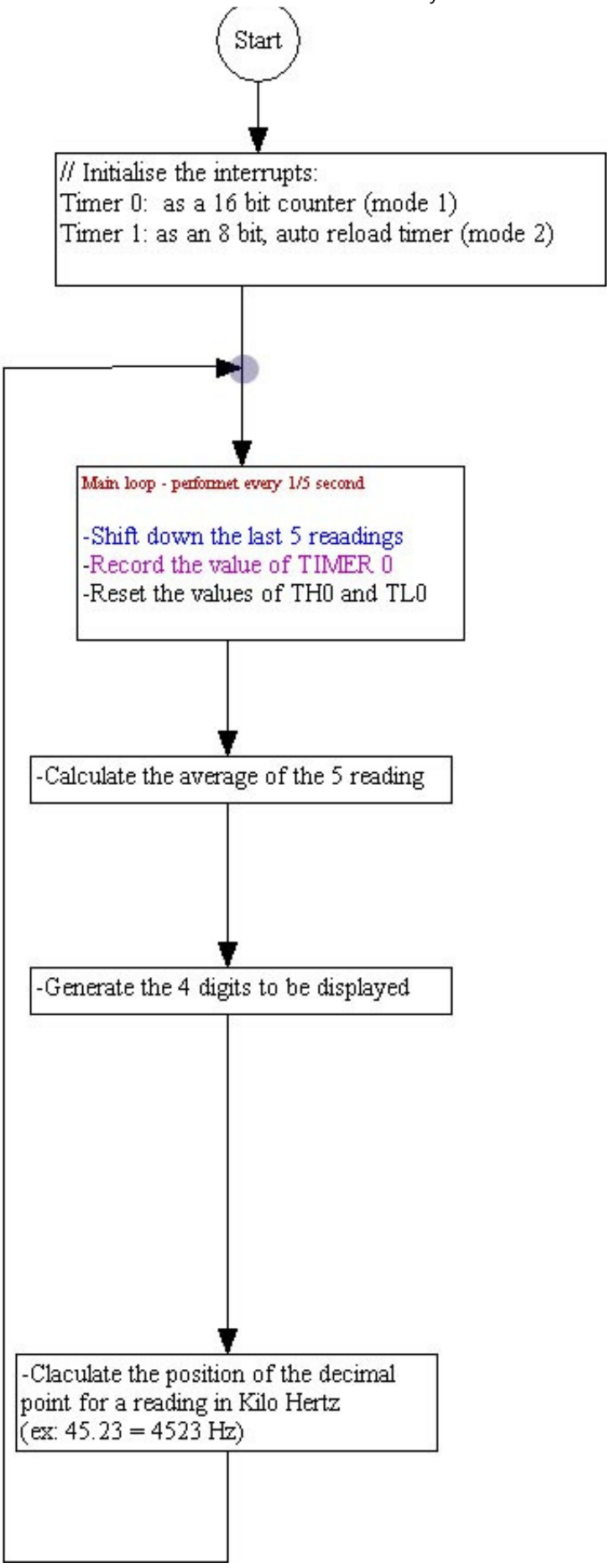
NOTE: While I tried to make things as clear as i could, this is not a tutorial to explain to beginners what is a microcontroller and how to use it...

Now you have to bear in mind the simple block diagram of a frequency meter shown at the top of the page. You can download the whole code in one file here, but even a professional programmer would easily get lost in someone's else code, so my advice is to try to understand how it is working, and then write your own version of the code.

■ The Main loop

Now, here is a simplified flow chart of the main loop. next to each box, you can see the corresponding source code, this can help you to understand how each step is programmed.

```
setup_interrupts(){
EA = 1;
ET0 = 1; //Enable the Timer/counter 0 interrupt
TR0 = 1; //Enable Timer/counter 0 to count
TMOD = 0X25; //counter 0 in mode 1 (16 bit
counter) , timer 1 in mode 2 (auto reload from TH1
TL0 = 0; //empty the counting registers
TH0 = 0; //empty the counting registers
TH1 = 100; //start timer 1 from 0
ET1 = 1; //enable timer 1 interrupt
```




```
TR1 = 1; //Enable Timer/counter 1 to count
PT0 = 1; // Lower priority for timer 0
PT1 = 0; // higher priority for timer 1
}
calc_del++;
if (calc_del > (2248/scale)){ // update data
calc_del = 0;
f = (TL0 + (TH0* 256));
sample[4] = sample[3];
sample[3] = sample[2];
sample[2] = sample[1];
sample[1] = sample[0];
sample[0] = f;
TL0 = 0; // reset the two registers of
TH0 = 0; // the 16 bit counter
f = floor(
(sample[0] + sample[1] + sample[2]+
sample[3]+ sample[4]) /5
)*scale;
void int_to_digits(unsigned long number){
float itd_a,itd_b;
itd_a = itd_a = number / 10.0;
dig[3] = floor((modf(itd_a,&itd_b)* 10)+0.5);
itd_a = itd_b / 10.0;
dig[2] = floor((modf(itd_a,&itd_b)* 10)+0.5);
itd_a = itd_b / 10.0;
dig[1] = floor((modf(itd_a,&itd_b)* 10)+0.5);
itd_a = itd_b / 10.0;
dig[0] = floor((modf(itd_a,&itd_b)* 10)+0.5);
}

if (f < 1000){
pt[0] = 128;
pt[1] = 0;
pt[2] = 0;
pt[3] = 0;
}else if ((f > 999) & (f < 10000)){
f = f / 1;
pt[0] = 128;
pt[1] = 0;
pt[2] = 0;
pt[3] = 0;
}else if ((f > 9999) & (f < 100000)){
f = f / 10;
pt[0] = 0;
pt[1] = 128;
pt[2] = 0;
pt[3] = 0;
}else if ((f > 99999) & (f < 1000000)){
f = f / 100;
pt[0] = 0;
pt[1] = 0;
pt[2] = 128;
pt[3] = 0;
}else if ((f > 999999)){
f = f / 1000;
pt[0] = 0;
pt[1] = 0;
pt[2] = 0;
pt[3] = 128;
}
```

The Counter and the Timer.

- the function **count_pulses()** , which is linked to the "**Interrupt 1**", will be executed each time the **TIMER 0** overflows. Actually this should never happen, because the counting registers are emptied every 1/5 second (if scale = 5, by default), but in case the timer overflows, we should increase the variable: "scale", hence the counting variables will be emptied every 1/6 second, and if the the TIMER 0 still overflows, scale will be increased to 7, and so on, until the system stabilizes at a point where the counting registers are being emptied fast enough, then the calculated frequency is correct.

```
count_pulses() interrupt 1 //counter 0 interrupt
{
if (scale < 200)
scale++;
}
```

- The function **calc_and_disp()** will be executed every 0.66 millisecond (*this is defined by the variable TH1 in the **setup_interrrupts()** function*) Each time this function is executed, one of the 4 7-segments is energized, and a corresponding digit is being sent, then, next time the function is called, the next digit is energized to show the next corresponding number... And the sequence goes on as explained before in the display system
Note: **dcnt** is the variable used to select on of the 4 display cells.

```
calc_and_disp() interrupt 3 {
P0 = (bcd[dig[3-dcnt]] - pt[3-dcnt]) ;
P1 = ord[3-dcnt];
dcnt++;
if(dcnt > 3){
dcnt = 0;
}
}
```

Now you should be able to build your own Frequency meter. To help you a litle more, I'm giving you a zip file containing the full schematic, the PCB design and the source code. *[**note: i use ExpressPCB(FREEWARE) to design the schematics and the PCB**]*

Download the zip file for this project

Discussion (Last 15 posts preview...)

Preview of the last 15 messages discussing this page. Messages are sorted from the newest to the oldest.

Follow this discussion in the Full-featured forum POSTREPLY

Posted by: 500 Khz Frequency meter (using AT89S52) ['Quote']

Posted by:
fathi
on: 12 Jan 2011

500 Khz Frequency meter (using AT89S52) ['Quote]

Hi Ibrahim ,

if I replace the AT89C52 with the Pic16f877A what I have to change than to get some good results ?

thank you in advance.

Posted by:
fathi
on: 26 Dec 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

Good Day Mr:Ibrahim,
I did everything as you said ,
but when I connect the battery the 7segments start to give numbers and some times nothing , no light
'the device is not connect it to nothing but it gives numbers and if I switch off than on will give different numbers again...etc

regards:Fathi

Posted by:

ikalogic
on: 25 Dec 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

> ***Quoting Fathi:*** *maddy*
>
> *since no body answer us and as I see that you have been done the device ,*
> *so please help the rest > please send some of it closer and clear than ...*
> *500 Khz Frequency meter (using AT89S52)*
> *apparently that Mr:Ibrahim is not care about us >>>!!!*
>
> *so we can help each other .*

Fathi,

It's not that i don't care, it's that it have been years since i last used a 8051. I don't even have the tools (software/hardware) to develop 8051 applications..

Anyway, i also don't understand what is your problem and how can i help...?

Posted by:
fathi
on: 25 Dec 2010

500 Khz Frequency meter (using AT89S52) ['Quote]

maddy

since no body answer us and as I see that you have been done the device ,
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500 Khz Frequency meter (using AT89S52)
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500 Khz Frequency meter (using AT89S52)
apparently that Mr:Ibrahim is not care about us >>>!!!

so we can help each other .

Posted by:
fathi
on: 24 Dec 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

we had been waiting a long time but no body answer !!!

so please if there is any one has been done this project to help the rest >please ...
500 Khz Frequency meter (using AT89S52)
apparently that Mr:Ibrahim is not care about as>>>!!!

so we can help each other .

regards Fathi

Posted by:
hrac5552
on: 24 Dec 2010

500 Khz Frequency meter (using AT89S52) ['Quote]

Hello , I want to make Frequency meter with frequenzy from 1 Hz to 147 Hz , or to 584 Hz ,
can I use this scheme for that , or how to do it ? Thanks . Dominik

---

Posted by:
icesky
on: 10 Nov 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

Hello ! I'm student and I'm trying to do the same project ! With the difference of limit of 2MHz.

Trying to take ur example, I loaded the *.hex to AT89C52 of Proteus, but I doesn't work, I've checked ur code and are somethings that I'm not understan very well.

Basically we take an external input for Timer 0 and that is our frequency to measure ? I really apreciate if u can give some help or orientation about this !

Something like the algorithm of ur program for better understanding  !

Posted by:
fathi
on: 26 Oct 2010

500 Khz Frequency meter (using AT89S52) ['Quote]

Good day Mr : Ibrahim
I would like to know about how to make the software < then how to connect the microcontroller for the software .
regards Fathi

Posted by:
lala
on: 27 Apr 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

Quoting ikalogic:

> ***Quoting Lala:*** *Hi!!! I need help with the frequency meter I'm trying to burn the code in to an AT89S52 but when I do it, it doesn't work :S can you please tell me if I must change*
>
> *something in the programing??? AGAR ... Thx*

something in the programing??? ASAP...Thx

Tell us some more info... after you burn and verify, verify is OK?

when you say it doesn't work, u mean no any LEDs light? what exactly is the situation?

More info
After I burn the micro it doesnt even turn the displays on :S A putted a frequency generator in the pin so it will read something and that didnt work ether but it doesnt give me any problems compiling or anything like that, I wanna know if there its something in the code the I have to change cus Im not using the same microcontroller that you did, Im using an AT89S52 :\

Posted by:

ikalogic
on: 23 Apr 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

Quoting Lala: *Hi!!! I need help with the frequency meter I'm trying to burn the code in to an AT89S52 but when I do it, it doesn't work :S can you please tell me if I must change something in the programing??? ASAP...Thx*

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Posted by:
lala
on: 22 Apr 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

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//More info
After I burn the micro it doesnt even turn the displays on :S A putted a frequency generator in the pin so it will read something and that didnt work ether but it doesnt give me any problems compiling or anything like that, I wanna know if there its something in the code the I have to change cus Im not using the same microcontroller that you did, Im using an AT89S52 :\

Posted by:

ikalogic
on: 17 Mar 2010

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

Quoting mani420: *hi ibrahim can i use Quad 7-segment display...???or not...and tell me how can i use it*
Thanks
Mani

Look at the 40MHz frequency meter project, it uses a Quad 7-SEG

Posted by:
mani420
on: 13 Mar 2010

500 Khz Frequency meter (using AT89S52) ['Quote]

hi ibrahim can i use Quad 7-segment display...???or not...and tell me how can i use it
Thanks

Mani

Posted by:

ikalogic
on: 03 Nov 2009

Re: 500 Khz Frequency meter (using AT89S52) ['Quote]

> ***Quoting chats:*** *Can this meter be used to verify output of a frequency generator.? what are TTL frequencies?*

TTL = Transistor to Transistor logic, it is the most basic 0V / 5V logic levels.

POST A REPLY

Subject: 500 Khz Frequency meter (using AT89S52)

Insert BB code:

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