E K U S E H E   B A N G L A
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H o m e   **Projects Page**

Very Precise LC Meter

Free for educational use only! ! !
For commercial use or manufacture please <u>contact</u> author ! ! !

DESCRIPTION: Well this is a Very Accurate *LC Meter based* on PIC 16F628A .Having inspired from <u>surprisingly accurate LC Meter</u>. This is my attempt to build an accurate L/C meter. This design is little different from other designs found on the internet. The goal of my hard work is to people get success in a single try. Cz Most of the design doesn't work as described in the documentation or lack of information's. The most challenging part of the project was to program the entire floating point math in 2k code memory of 16F628A.

 Basically LC meter is a kind of frequency meter, there is an LC Tank oscillator that oscillates with measured L or C and result is being calculated. The precision of frequency is up to 1Hz. For more details of measuring frequency with timers, see my article frequency counter..
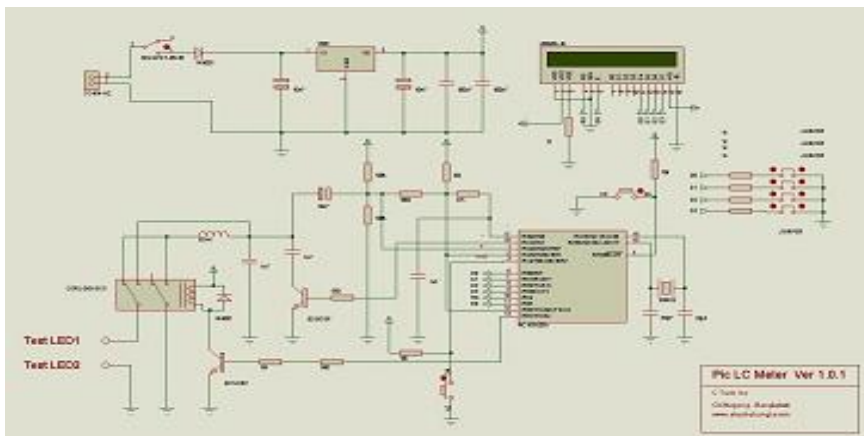
Theory of operation: Look at the schematic carefully; I didn't use any reed relay, which is the burden for most of hobbyist, because of unavailability in local market. In my country (Bangladesh) it is also not available. So first I decided to use a Mosfet instead of Reed Relay. But I found better result in normal NPN transistor like BC547. If you don't trust transistors, you can add Reed Relay yourself. I have used Pic's internal comparator for oscillator and fed it to Timer1 External clock source to calculate frequency. So it eliminates the external Lm311 Op amp .The relay RL1 used for selecting L and C mode. The meter works on four basic equations. This are

For Capacitor	For Inductor
$$F_1 = \dfrac{1}{2\pi\sqrt{LC}} \quad\text{------------- (1)}$$ $$F_2 = \dfrac{1}{2\pi\sqrt{l(C+C_{cal})}} \quad\text{----------(2)}$$ $$F_3 = \dfrac{1}{2\pi\sqrt{l(C+C_x)}} \quad\text{----------(3)}$$ $$C_x = \dfrac{\left(\frac{F1}{F3}\right)^2 - 1}{\left(\frac{F1}{F2}\right)^2 - 1} \, X \, C_{cal} \quad\text{-----(4)}$$	$$F_1 = \dfrac{1}{2\pi\sqrt{LC}} \quad\text{------------- (5)}$$ $$F_2 = \dfrac{1}{2\pi\sqrt{l(C+C_{cal})}} \quad\text{----------(6)}$$ $$F_3 = \dfrac{1}{2\sqrt{(l+l_x)C}} \quad\text{----------(7)}$$ $$L_x = \left\{\left(\tfrac{F1}{F3}\right)^2 - 1\right\} \times \left\{\left(\tfrac{F1}{F2}\right)^2 - 1\right\} \times \tfrac{1}{C_{cal}} \times \left\{\tfrac{1}{2\pi F1}\right\}^2 \quad\text{----(8)}$$

For both unknown L and C, Equation 1 and 2 are Common. Means we get F1 with internal LC tank circuit then connect Ccal Parallel with tank circuit and take the value of F2.
Afterwards,

1. For Capacitor it takes F3(Eq3) keeping the Cx Parallel with tank circuit then Calculates Cx from Equation 4
2. For inductor it takes F3 (Eq7) keeping Lx series with internal inductor of tank circuit and calculates Lx from Equation 8

So, For Both Inductor and capacitor equation 1, 2, and equation 5, 6 are same.
After getting the raw value of inductance or capacitance, program automatically scales the value to engineering unites. Then shows it to 16x2 LCD with unites.
If it is hard to understand all the maths better leave for a while and try to make the hardware first and go through the calibration process I referred in next section.

Construction:
Precision depends on the status of your components. The two 33pf capacitors in the oscillator should be tantalum (for low series resistance/inductance). Use C4, C5 (Ccal) Polystyrene type. Because Green caps tend to drift in value too much. Avoid ceramic capacitors. Some of these can have high losses (and it is hard to tell).

1. First check all parts according to the schematic placed perfectly.
2. Program the chip (16F628A) with the Hex file given below the Page. If you don't have a programmer / loader check my PicKit-2 clone. It's easy to make
3. Connect power to the circuit without the chip first, then check the IC Base pin no 5, 14 with a volt meter. You will find 5v if everything ok.
4. Put the Chip on Ic Base and connect the power, If you find LCD is much contrast, increase the value of R11 to several kilo ohms.

Calibration:

1. Keep short two test leds and switch on the circuit. It will then auto calibrate. And default mode is inductance. Allow several minutes "warm-up", then press the "zero" button to force a re-calibration. The display should now show ind = 0.00 uH
2. Now Open two test leds and connect a well known value of inductor like 10uH or 100uH. The LC meter should read somewhere near its value (with up to +/- 10% error).
3. Now you need to tune the meter to show the result near +/- 1% . To do so check the schematic there is 4 jumpers Jp1 ~ Jp4. Jp1 and Jp2 are delivered to + and – the value. To increase the value first join Jp1 and run the process 1,2. And to decrease the value Join Jp2 and run the process 1,2.
4. Once it shows the desired value, remove the jumpers. Now the chip will remember the calibration until you change it again.
5. If you still not get the perfect value, join the Jp3 to see the Value of F1. It will show near about 503292 with 100uH L and 1nF capacitor. Or join Jp4 to see F2. If doesn't shows anything that means your oscillator is not working perfectly. Check your PCB again.
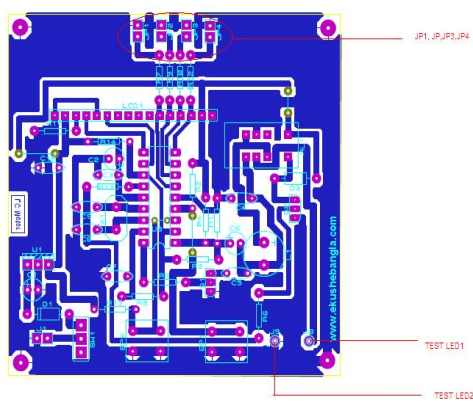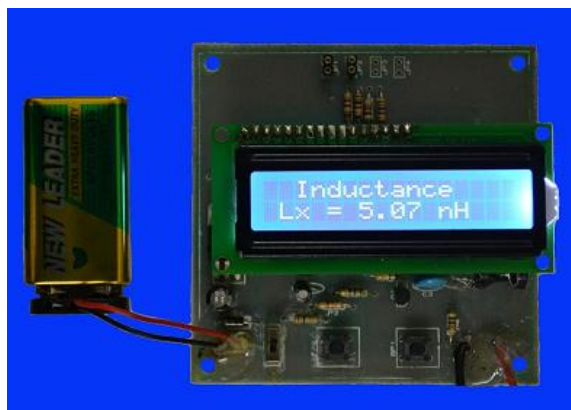
Practical Image Of LC Meter

Find the Artwork and Hex here.

For any other help leave a comment or contact me on email.

Featured Comment

ronyintel Mod → Sergey Lebedev • 2 years ago
Dear All
Please give Sergey Lebedev a big Hand. He did a
good Version of PCB and Nice modification of the
meter.

I have seen ur images. It looks Great :).
https://plus.google.com/photos...

Calibration process is very easy. Take a known
value of inductance, Say 100uh. And measure it.
When your meter shows less then the value of its
original, then u must need to increase the
calibration value. To do so, please switch off the
meter, connect two crocodile clips each other,
short JP1 and switch on. Now measure the 100uh
inductor. Do it again and again until u get the
desired value. And if u need to decrease the value
Play same with JP2.

I will share all ur images and layout design soon to
my page
       ∧   ∨   • Share ›

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│   │
└───┘

Scourge • a month ago

any chance of running it with the 16f88 ?
∧ ∨ • Reply • Share ›

Arshad PC • 4 months ago

Can you let me know what should I change in coding if
I use 8 MHz crystal in place of 16 MHz:????
∧ ∨ • Reply • Share ›

> **ronyintel** **Mod** → Arshad PC • 4 months ago
>
> Sorry Arshad PC
>
> You cannot use Avr loader for microchip Pic
> and the project is based on frequency. So
> there is no chance to replace 8mhz crystal.
> Thanks
> ∧ ∨ • Reply • Share ›

vas • 4 months ago

The hex file is for LCD with 1 line characters or for
LCD with 2 line characters?
Thanks.
∧ ∨ • Reply • Share ›

> **ronyintel** **Mod** → vas • 4 months ago
> The Hex is for 2 Line LCD. :)
> ∧ ∨ • Reply • Share ›

vas • 4 months ago

In "photos" is used LCD named GDM1602A, in
schematics is used LCD020L-BL. I have GDM1602S!
These is equivalent?
Thanks
∧ ∨ • Reply • Share ›

vas • 4 months ago

Please explain: LM020L-BL have 1 characters line,
but you use a LCD with 2 line characters.
What type is it?
Thanks.
∧ ∨ • Reply • Share ›

> **ronyintel** **Mod** → vas • 4 months ago
> Its a 2 line LCD. i jut wrongly write LM020l :)
> ∧ ∨ • Reply • Share ›

Ricardo Clerici • 6 months ago

Hello: please, I want to know the final resolution of
your model. As I see in the photo you can reach 5 nH
readings: is it correct?. I 've built up Phill Rice's
design, it runs ok but the resolution is 10nH. I would
be very interested in your design if it can measure
such a low L values. Thank you and best regards.
Ricardo _LU7CRA , from Argentina
∧ ∨ • Reply • Share ›

Poulomi Mitra • 6 months ago

does the schematic works on proteus with the given
code

∧ ∨ • Reply • Share ›

Arshad PC → Poulomi Mitra • 4 months ago
Have you tested this circuit?

∧ ∨ • Reply • Share ›

ronyintel **Mod** → Poulomi Mitra
• 6 months ago
Dear Poulomi ,
Proteus can't simulate everything. U Only can
Partial simulate of the circuit. Thanks

∧ ∨ • Reply • Share ›

Ashok RAMABHAI PATEL • 7 months ago
Do not worry about relay, for trial you can avoid pic pin
13 open and no transistor and no relay and directly
solder known value inductor between ground and
82uH inductor lead.This is for trial only if success u
can arrange relayafterwords to measure both L And C
.

∧ ∨ • Reply • Share ›

Ashok RAMABHAI PATEL • 7 months ago
It works for me for PIC16F628A as per provided
schematic and Hex file is for pic16f628A. I made it and
working.

∧ ∨ • Reply • Share ›

Ashok RAMABHAI PATEL • 7 months ago
I mabe it success fully on proto type pcb and
measures inductance correctly
Any friend can implement but with accuracy and
sujjested components type and good quality
components for perfect results.

To increase the value of inductance if it shows less
then jumper jp2 worked for me instead of jp1...first to
try for jp1 and if it decreases value then try for
jp2(which increased value for me)
STEPS FOR CALIBRATION I DONE ARE AS
UNDER AFTER COMPLETING HARDWARE AND
SOFTWARE SECTION
1)Switch off the power and short the measuring leads
1 and 2.
2)Switch on the power
3)It will display the web name and calibrating message
then it will show some value of inductance like

see more

∧ ∨ • Reply • Share ›

venkat • 7 months ago
the pcb layout is in mirror position will you please
upload the correct one

∧ ∨ • Reply • Share ›

ronyintel **Mod** → venkat • 7 months ago
Dear When u print the layout of bottom side. U
must make it Mirror. I don't know what etching
Process u following. This is the link of etched

Process u following. This is the link of etched board
https://plus.google.com/photos...
But if needed i will upload one for u :)

⌃ ⌄ • Reply • Share ›

venkat ➜ ronyintel • 7 months ago
when ?

⌃ ⌄ • Reply • Share ›

Ashok RAMABHAI PATEL ➜ venkat
• 7 months ago
sir where are the video and pcb?

⌃ ⌄ • Reply • Share ›

ronyintel Mod ➜ Ashok RAMABHAI
PATEL • 7 months ago
Soon i will upload one. Till then please
wait. Currently some photos here
https://plus.google.com/photos...

⌃ ⌄ • Reply • Share ›

Ashok RAMABHAI PATEL • 8 months ago
Actualy used PIC16F628A OR IPC16F628 ?Any
friend please reply who had made it successfully...pl...

⌃ ⌄ • Reply • Share ›

venkat ➜ Ashok RAMABHAI PATEL
• 7 months ago
will you pls send me the pcb layout to my mail
id venkat46c@gmail.com

⌃ ⌄ • Reply • Share ›

ronyintel Mod ➜ Ashok RAMABHAI PATEL
• 8 months ago
PIC16F628A is good for it. This project is very
simple to make, and worked well for me.
Thanks

⌃ ⌄ • Reply • Share ›

Tinca Niculita • 2 years ago
Hello my friend .. are Nicu from Romania

I hope my English will not create porbleme ... :))

I made myself this device and have a single problem
with it. Measures approximately 10-15% relative fair
values higher than those written on pieces. The
problem is that the adjustment does not work (J1 and
J2) does not change the displayed value. What could
be the problem?

You toast my self to open it attaches to those trying to
learn her secrets and microcontrollers.

respect

⌃ ⌄ • Reply • Share ›

Fazal Hashmi • 2 years ago
Hello .Thanks for share an interestring Project .Bro i
have complete work for this project but the lcd does'nt

show any character, just glow and my pic get very hot
,the circuit draws a 1500 mA current.plz help me.

2 ∧ ∨ • Reply • Share ›

Jens Schriever • 2 years ago
Hello Sir,
i want to build your project for me. Is the relay state in
the schematic for Cx or Lx measurement?
When will Q1 be turned on?
What function have BP1 and BP2?
What mens LED1/LED2? So i think i need the LEDs
for calibration, right? but why? How to connect them?
Thanks a lot!

∧ ∨ • Reply • Share ›

ronyintel Mod → Jens Schriever
• 2 years ago
I will upload a video of practical LC meter. Till
then PLZ Wait :)

1 ∧ ∨ • Reply • Share ›

G. Fellow → ronyintel • 2 years ago
Hey, how long does it take?

∧ ∨ • Reply • Share ›

ronyintel Mod • 2 years ago
New version is almost complete. i will publish it soon.
And Relay is nothing special here, use any relay of 5v
and DPDT, Pins must be connected as the schematic.
And it will work fine. The job of relay is only select the
mode L or C. Hope u all understand :)

∧ ∨ • Reply • Share ›

Sudipta Ghose → ronyintel • 2 years ago
ধন্যবাদ! রিলেটি কিন্তু পিসিবিতে বসিয়ে ঝালাই করা
যাবেনা।

∧ ∨ • Reply • Share ›

Sudipta Ghose • 2 years ago
The relay size on the PCB is an issue. What relay
have been used by the enthusiasts? The specified
relay is oversized.

∧ ∨ • Reply • Share ›

Tim Xánh • 2 years ago
You have completed the new version yet? Thanks

∧ ∨ • Reply • Share ›

AMR • 2 years ago
Hi! I couldn't find the 82uH inductor you used in this
meter. Can i use alternative L like 100uH or 65uH?
And what is the type of the relay used here?
Thanks.

∧ ∨ • Reply • Share ›

ronyintel Mod → AMR • 2 years ago
Yes u can use 100uh inductor. It will then
change highest and lowest value of inductance

and capacitance it can measure. But The
result will show still correct , Because in
equation u can see L value disappears after
calculation :), enjoy

⌃   ⌄   • Reply • Share ›

ronyintel Mod • 2 years ago

Hello every one. Thanks for the interest on my project.
I am now developing more precise LC meter shortly. I
will Upload everything soon. Ur interest drag me to
redevelop this :). Thanks

6 ⌃   ⌄   • Reply • Share ›

Edba • 3 years ago

I wanted to build LC meter according to:

http://www.vk6fh.com/vk6fh/lc_...
http://electronics-diy.com/lc_...
https://sites.google.com/site/...
http://www.circuitvalley.com/2...

But then I found this your interesting project - witty
connection at the LCD display brightness control,
replacement of the switches by the relay and a
professional attitude.

I will definitely try out.

⌃   ⌄   • Reply • Share ›

ronyintel Mod ➜ Edba • 3 years ago

Please Read the instructions carefully before u
implement it. Check relay diagram and
schematic. U must success.

And thanks for the interest on my project. I am
using it professional

⌃   ⌄   • Reply • Share ›

riphoe ➜ ronyintel • 2 years ago

send me your e-mail

⌃   ⌄   • Reply • Share ›

ronyintel Mod ➜ riphoe
• 2 years ago

to get email id please goto home
and click contacts
you will get my Phone No and
email and my living address :)

⌃   ⌄   • Reply • Share ›

Haisan Marian • 3 years ago

Hello,
I have build this LC meter but after i plug a wire
between the two test leds, the circuit do not calibrate;
over range message appear. What should I do?
Thanks!

⌃   ⌄   • Reply • Share ›

ronyintel Mod ➜ Haisan Marian
• 3 years ago

Dear hasian Marian. Please read the instructions carefully 1,2,3,4,5. on the page.

First switch off the circuit. then connect two leads together. Then switch on. It will show calibrating..... afterwords an initial value will come On lcd. Then Disconnect two leads from each other then Meter will show Over Range 0.00. That means its ready for measurement. Then Put any unknown value (L) between two leads ; now it will show the inductance of unknown value of inductor. Thanks

︿   ﹀   •   Reply   •   Share ›

Haisan Marian → ronyintel
• 3 years ago

Thanks to your quick response. I have identified the problem. Due to a mistake I have used a 4.7K resistor instead of 47k. Now I can accurate measure inductance but one problem remains: the capacitance meter doesn't work. I tried to push the switch button, the lcd says that I'm in Cx mode, but when I try to measure any capacitor the 700pF apears. I have verified the schematic and all parts are good. I don't know what else to try...

1   ︿   ﹀   •   Reply   •   Share ›

ronyintel Mod → Haisan Marian • 3 years ago

After Push the switch You will hear the sound of relay Change Over. If u can hear its ok. Then check Relay NC/NO according to The Schematic. Im sure U are using Another Kind of relay. So, Please Match NC/ NO as referred on Schematic. And thanks for the interest On My Project :)

︿   ﹀   •   Reply   •   Share ›

CHR0N0S • 3 years ago

POLIESTIRENE DE 1NF? TANTALUM 33PF?

︿   ﹀   •   Reply   •   Share ›

marcony • 3 years ago

thank you very much you are so helpful

︿   ﹀   •   Reply   •   Share ›

marcony • 3 years ago

I whant to add a ver. pot for contrast lcd and REG 7812 for ext. PSU can u help me

︿   ﹀   •   Reply   •   Share ›

ronyintel Mod → marcony • 3 years ago

Sure Please check this link

http://www.4shared.com/zip/UGu...
I have uploaded edited layout as ur demand.
Thanks
∧   ∨   • Reply • Share ›

marcony • 3 years ago
did you have the original pcb sch files drow in eagle,
orcad or atium...I need to replace the components
∧   ∨   • Reply • Share ›

    ronyintel Mod ↗ marcony • 3 years ago
    Sorry i only design in Proteus. if u need
    Proteus design file i can share or which
    component u want to replace please notify me
    ill change design for u in Proteus. Thanks
    ∧   ∨   • Reply • Share ›

ronyintel Mod • 3 years ago
Please do not write here after simulate it in Proteus.
CZ Most of the time Proteus can't simulate at real time
due to excessive load on CPU. Better Make the little
circuit yourself and write. Ill help if any problem.
Thanks to all friends who is showing interest for this
project
∧   ∨   • Reply • Share ›

Tornado2 • 4 years ago
Hi
I have been searching for a LC meter for a long time. I
am almost ready to "burn" the PIC and start the
assembly of the parts on the PCB. I really liked the
reed realy substitute :)
I will let you know when I am done
Excellent job

Cheers

Al
∧   ∨   • Reply • Share ›

    ronyintel Mod ↗ Tornado2 • 4 years ago
    Thanks in this project a simple BC547 NPN
    transistor is working better then a reed relay.
    ∧   ∨   • Reply • Share ›

        Tornado 2 ↗ ronyintel • 4 years ago
        Well , after 3 months of getting the PIC
        burned, pc board completed, I tested it.
        Unfortunately I didn't get the expected
        results. Apparently the oscillator works,
        but the readings are not correct.
        I have some pics and short video that I
        can send to you so may be you can
        give me some tips.
        Any help is appreciated

        Al
        ∧   ∨   • Reply • Share ›

        ronyintel Mod ↗ Tornado 2

ronyintel → Tornado2
• 4 years ago

Ok Tornado2 , Did you Make
this Project (what i have
described in this page), Or it is
your own project?? Please
send me the video and pictures,
So i can see what is the
problem in your board. the email
id is electrorony@gmail.com

∧   ∨   • Reply • Share ›

Tornado2 → ronyintel
• 4 years ago

Yeah, it is your project. I didn't
change anything. I ve just
followed what you described in
the info. Later on I will send you
the pics and video to your email