

## RLC-2

### 1. Specifications

Measured parameter	Test Signal Frequency		
	100Hz	1KHz	10KHz
R	0.01 $\Omega$ - 100M $\Omega$	0.01 $\Omega$ - 100M $\Omega$	0.01 $\Omega$ - 100M $\Omega$
C	1pF - 22000 $\mu$ F	0.1pF - 2200 $\mu$ F	0.01pF - 220 $\mu$ F
L	1 $\mu$ H - 20KH	0.1 $\mu$ H - 2KH	0.01 $\mu$ H - 200H

Modes:

- The frequency of test signal 100Hz, 1kHz, 10kHz;
- The amplitude of the test-signal 0.3V;
- Serial / parallel (s / p) scheme replacement - automatic / manual selection range;
- Display Hold;
- Compensation parameters CP and XX - displaying the results of measurements in the form of:
  - R + LC
  - R + X
  - Q + LC (quality)
  - D + LC (tg angle losses)
- Submission of constant voltage bias element tested at 0-30V (from internal sources);
- Measuring the voltage bias (0.4V-44V);
- Submission of the DC bias on the tested element (from an external source):
- Debug mode.

The maximum time for measurement:

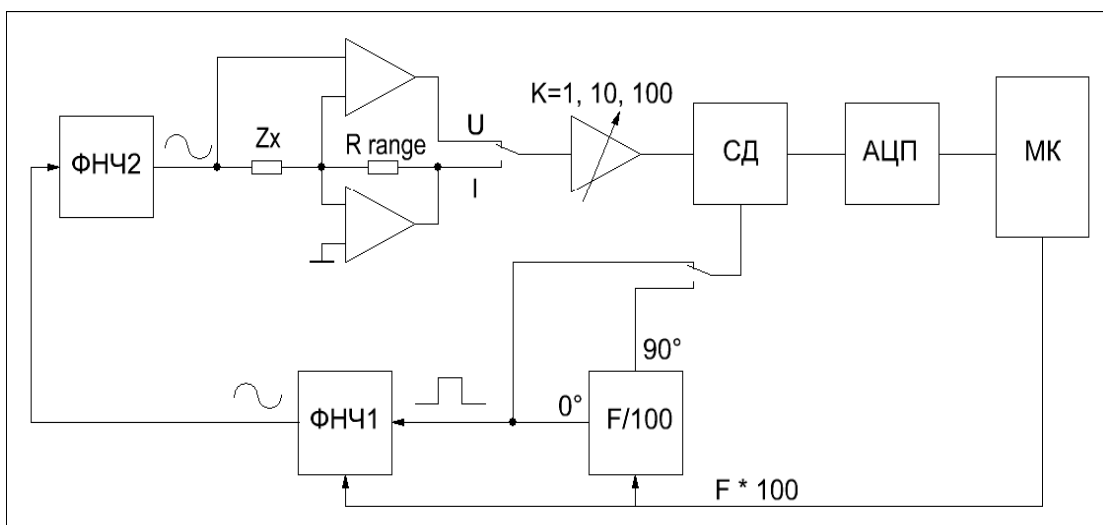
- 100Hz - 1.6s
- 1kHz, 10kHz - 0.64s.

### 2. How it works

At the core of the device is based on the method and voltmeter ampermetra, ie measured voltage drop on the test cell and a current through it, and is calculated as  $Z_x Z_x = U / I$ . Of course, the value of current and voltage necessary to obtain in a complex manner. To measure the real (Re) and imaginary (Im) of voltage and current using synchronous detector (SD), which in turn is synchronized with the test signal. By filing for key management board meander shift from 0° or 90° on the test

signal, we get the desired Re and Im parts of voltage and current. Thus, for a single measurement  $Z_x$  to perform four measurements, two for two for the current and voltage. Signal to the CD in digital form has dual ADC integration. The choice of this type ADC due to its low sensitivity to interference, and that the ADC integrator role additional filter the signal after the board of directors.

Test signal is produced from a meandering after FNCH1 (low-frequency filter for the switched capacitors) and FNCH2 (normal double RC filter), which removes the remnants of the frequency  $F * 100$ .



The device used to measure the current active (in the OC) current-voltage converter. Applying the principle of «small fine, a lot», МК manages choice R range and  $K_u$  amplifier according to the following table to ensure maximum indication ADC:

Range	R range $\Omega$	$K_u$ for the current	$K_u$ for the voltage
0	100	1	100
1	100	1	10
2	100	1	1
3	1k	1	1
4	10k	1	1
5	100k	1	1
6	100k	10	1
7	100k	100	1

### 3. Scheme

The scheme is divided into three parts:

- Analog part;
- Digital part;
- The power supply

Nothing is born out of nowhere, so in our case. Some sites and ideas were "borrowed" from the schemes of industrial equipment, available in the public domain - LCR-4080 (E7-22), RLC-9000, RLC-817, E7-20.

The device works as follows.

Microcontroller (MC) PIC16F876A formed SinClk (RC2, vyv.13) meander frequency 10kGts, 100kGts or 1MGts. The signal is fed to the input divider performed on chips DD12 and DD13. At vyv. 10 DD12 receive frequency SinClk/25, which in turn is further divided into 4. At the exits shift register receives shifted relative to each other at 90 °, necessary for the board. The signal is fed to 0\_Clk chip DA6, is an elliptic filter 8-th order. This filter is allocated first harmonica. The frequency filter cut-off determined by the frequency signal to be applied to the digital input (vyv.1 DA6). The resulting sinusoidal signal (the first harmonic) further filtered double RC-chain R39, C27, R31, C20. At the lower range of 1kHz and 100Hz, respectively, to further connect C28, C21 and C26, C25. After output buffer DA3 sinusoidal signal through restrictive resistors R16, R5 and split capacitor C5 comes to Zx. The amplitude of the test tone idling around 0.3V.

The drop in voltage on the Zx (voltage channel) is removed through the capacitors C6 and C7, and supplied to the entrance of instrumental OU (IOU), performed at DA4.2, DA4.3 and DA4.4. Gain this IOU is determined by the ratio  $R28/R22 = R27/R23 = 10k/2k = 5$ . In a key DA7.3 analog signal is fed to an amplifier with a variable Ku. Required gain (1, 10 or 100) is set signals Mul10 and Mul100. Then the signal is fed to the board DA9. On key management board filed meander with a frequency of test signal from the shift of 0 ° and 90 °. Thus, highlighted the real and the imaginary part of the signal. Alert after key board integrated supply chain R41-C30 and R42-C31 and fed to a differential input ADCs.

Talk through Zx is converted to the voltage at DA1 with a set of 4 resistors (100, 1K, 10K and 100K) in the feedback, switchable via DA2. The differential signal conversion is removed through the C18 and C17 and fed to the entrance IOU

performed on DA5. Since its output is supplied to the analog key DA7.3.

Reference voltage 0.5V ADC is on parametric inhibitor R59-LM385-1.2V and then delitele R56, R55. ADC clock AdcClk (frequency 250kGts for measurements at 1kHz and 10kGts, frequency 100kHz to 100Hz), a USART module in synchronous mode with the release RC5. At the same time he served at the conclusion RC0, which is installed as an entry TMR1 in counter. The digital code conversion ADC is the number of pulses AdcClk minus 10001 for the time until the signal Busy ADC is in the "1". This feature is used to input the results of the MC / D conversion. Busy signal is fed to the withdrawal of RC1, which is configured as an entry module compare and capture MK (CPP). Using stored value TMR1 a positive signal front Busy, and then at a negative. Subtracting these two values, we get the desired result of the ADC.

#### 4. Parts

We tried to choose parts based on the criteria of affordability, simplicity and a maximum frequency circuits. In our opinion the only scarce chip - it is MAX293. But its use has greatly simplify the site, which forms the reference sinusoidal signal (as compared to the same site, say, RLC4080). We also tried to reduce the variety of types of chips, resistors and capacitors values.

Requirement for Parts.

Separation capacitors C6, C7, C17, C18, C29, C36, C34, C35, C30, C31 must be the type of film MKP10, MKP2, K73-9, K73-17 or the like, the first four on the minimum voltage of 250V, for C29, C36, C34, C35, C30, C31 to 63V.

The most critical element of its parameters - is integrating capacitor C33. It should have low levels of dielectric absorption. Based on the description on the ICL7135, should be applied to the capacitor or polypropylene, or Teflon dielectric. Widespread K73-17 as an integrating capacitor give 8-10 error of ADC in the middle of the scale, which is totally unacceptable. Required capacitors with polypropylene dielectric were found in old monitors. If you choose a monitor for dismantling, with a thick handle video, there is a good flexible insulated shielded wires, will manufacture schupov to display.

Transistors VT1-VT5 can replace virtually any other NPN in the same case.

Sound radiator SP - electromagnetic, from the old motherboard. If the resistance is equal to 50-60 ohms, the extra R65, you can put to 0.

The details, which are encouraged to pick up a pair:

R41 = R42, C30 = C31 - to the board;

R28 = R27, R22 = R23 - IOU for stress;

R36 = R37, R32 = R33 - for the current IOU.

The details, which are encouraged to pick up exactly at par:

R6, R7, R8, R9 - on the stability of these resistors depends heat and the long-term stability of the instrument;

C20, C21, C25, C26, C27, C28 - particularly pay attention to the capacitors value 0.1 $\mu$ F;

R48, R49, R57, R58 - depends on their relationship to enhance the t-scaling amplifier.

LCD standard 2X16 characters met on HD44780 or compatible with the controller. To be sure, there are indicators, with varying distributing conclusions 1 and 2 - the land and food. Wrong inclusion would lead to the exit of the LCD! Check carefully the documentation for your display and visually on a plate!

## 5. Construction

The device is built on three boards:

- a. The main board analog and digital parts;
- b. Fee display;
- c. power supply.

Before you make payment, we suggest that you specify the size of its parts. This is particularly true for the capacitor. At the board room of the details with a sufficiently large size, but the test will not be too much.

The main charge double. The upper side is clear, to the common land. After a transitional holes (in RLC2.lay labeled through) the earth with the upper layer is connected to the bottom. At the holes under the discharge details from the top of the (land) must withdraw fasku drills 2.5mm. First payaem (or proklepyvaem copper wire and propaivaem) excavation jumper, then the output wires. Next zapaivaem SMD components: resistors, capacitors, diodes, transistors. It output details: pads, capacitors, connectors.

Fees are also two-sided display. The top layer of the earth - is playing the role of the LCD screen. Transient holes in the same used to connect the upper and the lower layer of the earth.

The payment LCD is desirable to connect to the main board ekranirovannym plume. It is made of 4-wire, over which has the normal sheath and conduit. Braiding zazemlyaetsya only from the main board. Train passed through a ferrite bead on some computer equipment. Thus, reduced to a minimum interference from the work of LCD.

Fee BLIs unilateral. There are two options under razvodki parts of different sizes. On the cards are not delivered at the entrance capacitors (220V) transformer and parallel diode bridge razvodku better finish and, if necessary, to place. A feature is a way to pay razvodki land "at one point." If you pererazvodit for some reason, save your configuration. It is important to choose a transformer with small losses (small talk XX). Before choosing or manufacture transformers refer to Article VT Poljakova «Reducing the field scattering transformer», published in zh.Radio, № 7 of 1983. Practice has shown that the Chinese consumer goods without rewinding normally does not work. Most likely, would have very namotat transformer based on the formula  $V_{\text{itkov}} / V = 55-60 / S$  ". This is not a typo it 55-60 / S, in this case, losses and laying of the transformer will be less. Transformer design is desirable to choose one in which the network and the secondary windings are located in separate sections. This will reduce the capacity between the windings.

## 6. Options button

Before describing the process of setting up the device will tell about the appointment of the buttons. Each button in the device has several functions, depending on the mode and time-pressed. There are long and short presses. Short - this time, when you click less than 1 sec., Accompanied by a single beep. If the button is pressed and held more than 1 sec. - A state of processed as a "long press of" and is accompanied by a second beep. Long presses are designed to switch between the work unit.

- Using measurements - the main mode of the device automatically after power.
  - S1 - alters the frequency of test signal (100Hz, 1kHz, 10kHz) in a circle
  - S2 - serial (s) / parallel (p) scheme replacement
  - S3 - mode display the results of LC / X (second line)
  - S4 - display of R / Q / D (first line)
  - S5 - the range of measurement Auto - the phone number with the number range displayed symbol «A», after you move in a circle ranges from current to 7, then 0 .. 7. Reverse include automatic selection of the range - a long press of S5
  - S6 - Hold testimony (Hold), the screen displays a symbol «H»
  
- Debug mode (Service mode), activated by pressing long-S6
  - S1 - alters the frequency signal test signal (100Hz, 1kHz, 10kHzs) circle
  - S2 - switches R range resistor in the converter I / U (100, 1K, 10K, 100K)
  - S3 - switch to the T-enhancing (1x1; 10h1; 1x10 1h100)
  - S4 - measuring the real (Re), imaginary (Im), both at once (RI) of voltage or current
  - S5 - measuring current mode or voltage
  - S6 - long pressing - Exit debugging
  
- Mode XX / BB calibration included long pressing S1
  - S1 - switches the type of calibration (Open-Short-Open and the like e.)
  - S2 - starts calibration selected (Open or Short). Short pressing any other buttons - exit in the main mode without calibration.

- Changing the correction factors, included a long pressing S3. Room rate of the number range, that is, for example, zero-to-t is used to adjust the testimony of zero range. K-t number 8 corrects testimony voltmeter voltage bias.
  - S1 - level left
  - S2 - down (reducing the value level)
  - S3 - up (increasing the value level)
  - S4 - level right
  - S5 - the next rate
  - S6 - Exit edit ratios
  
- "Long" pressing the buttons
  - S1 - includes calibration mode
  - S2 - are not involved
  - S3 - treatment includes correction coefficients
  - S4 - enables / disables the voltage and current in units of ADC in operation, is used for debugging.
  - S5 - includes automatic selection of measuring range
  - S6 - turns on / off mode debugging

## **7. Starting device**

Experience has shown that radio amateurs often make the installation of the device completely, and include meals. This in our view a bad approach, especially if used brazed parts (ie, potentially outside), or the installation of a very messy, with errors. This leads, as a rule, to additional damage and increase the time of launch and configure the device. We suggest that you run the RLC separate blocks. And if possible, before you install on a payment check all the details, which can verify. This will relieve you from nerazumeny kind of reading the inscriptions on perevernutyh SMD-resistors, installing dry electrolytes on nutrition, etc.

First, check the transformer and make sure that the voltage on the secondary winding ~ 8-9V. Drive it at idle, check the heating (iron transformers from Chinese BLIs per hour warmed to 60-70 degrees Celsius). Connect the transformer and check the power supply separate from the rest of the scheme, the output should be  $\pm 5V$  and  $+29.5-30.5V$ .

Checking platku LCD on k.z. Connect only the power to charge the display. The first line should appear black rectangles. This suggests that normally took place inside initialize LCD and correctly installed voltage regulating contrast.

MC program can be almost any programmer that supports PIC16F876A. MC can be programmed separately - in the



programmer, and at the plate through the slot ISCP. In this case, jumper Jmp1 be razomknuta.

Connect power to the main board without imposing any chips. To detect the voltage +5 V and -5V at the scene of the conclusions of the ICJ. Make sure that the entrances of DU, which are protective diodes, there is no tension. To check the "support" ADC - +0.5 V.

Set MC, connect the card display and includes meals -> on the display should appear greeting "RLC meter v1.0". So far, no A / D, the unit will not show other information, and will not respond to the pressing of buttons. This shows the correct proshitom MC. To detect the meandering 250kHzs "AdcClk" and meander, "SinClk" - 100kHzs (in sinus = 1kHz).

Sequentially install MS (do not forget to install switching off!) And check under the table:

	Set	Checking
1.	PIC16F876A	meander 250kGts "AdcClk"; meander 100kGts "SinClk"
2.	HC390 and HC164	meander 1kHz 0_Clk and 90_Clk; phase shift of 90°
3.	MAX293	on the C19 on the ground 1kHz sinusoidal signal magnitude 0.6V
4.	DA3 (TL081)	for the withdrawal of "I" connector connection Zx 1kHz sine magnitude 0.6V
5.	DA4	Conclusion 1 DA4 - sinus 1kHz scale 3B; Ku = 5 IOU
6.	Zx=100kOm, DA1, DA2	Sinusoidal signal conversion I / U on the withdrawal of 3 DA2 the magnitude of 0.6V
8.	DA5	Conclusion 1 DA5 - sinus 1kHz scale 3B Ku = 5 IOU
9.	DA7 and DA8	1kHz sine magnitude 3B at C29 on the ground (by doing U)
10.	DA9	Raznopolyarnoe voltage on C30, C31

Set the ADC, while connected  $Z_x = 100k\Omega$  on the screen should appear roughly as follows:



This demonstrates the proper work of the entire apparatus.

With a strong desire to further check the quality integrating capacitor. Look in the description on the ICL7135, where the verification process is described. Vynimaem chip DA9 of Plot jumpers earth withdrawal 9 (In-) ADCs. We connect the second input (10; In +) with the conclusion of 2 (Ref) / D, so served on the ADC input voltage reference. Turn the device and pressing the long-S4 translate it to display evidence ADC. The display must be four numbers 9999.

Next calibrate the device for precise resistance using correction factors for each range. We recommend to do so at a frequency of 1kHz, and use the following:

Range	R
0	1 Ohm
1	10 Ohm
2	200 Ohm
3	2k
4	20k
5	200k
6	2M
7	20M

This setup can be completed.

In conclusion, we cite the results of the measurements 0.2pF capacitor and choke 1mkGn at frequency 10kHzs evidence stable:

