THE DIGITAL FREQUENCY COUNTER
on the single-crystal microcontroller AT89c51

Range of measurement of frequencies ..... 1 Hz ... 1 GHz
A range of measurement of instability ..... +/-10 MHz
Quantity of bits of the indicator (99.999.999) 8
A discretization of counting..... 1 Hz
Time of measurement ..... 1 sec
Sensitivity ..... 100 ... 200 mV

This frequency counter was developed in far 1994. Though the subsequent years similar constructions have appeared many, in my opinion, and in XXI century the instrument is absolutely not obsolete, and on some parameters even exceeds later developments. After the publication I have received weight of responses among which practically there were no censures on quality of operation of the instrument and difficulty with adjustment.

For the given frequency counter the program " the New Year's souvenir " which outputs on the indicator dynamical a picture is developed. So, among other things, it can decorate your radiolaboratory in "New year". Frivolously? But it is no secret, as the most perfect computers frequently are used only as toys.

A principle of operation of the frequency counter – classical: measurement of quantity (amount) of impulses of an entry signal for the fixed time slice. Such interval selects 1 second that provides accuracy of counting - 1 Hertz. It is quite enough of it for the majority of the purposes. Power supply 5v on all chips is brought to output with maximum number. Output incorporates to a common wire about twice smaller number. Between chains of power supply it is necessary to include 2. 3 bypass capacitors 0,01. 0,1Мк. Chain C4, R1 is necessary for reset at inclusion of the network. Now it is possible to gain the microcontroller with the built - in memory of 87C51 programs or AT89C51. Between P0.0 - P0.7 and 5v it is desirable to include tightening resistors 10к though as practice has shown, the instrument is normal works and without them.

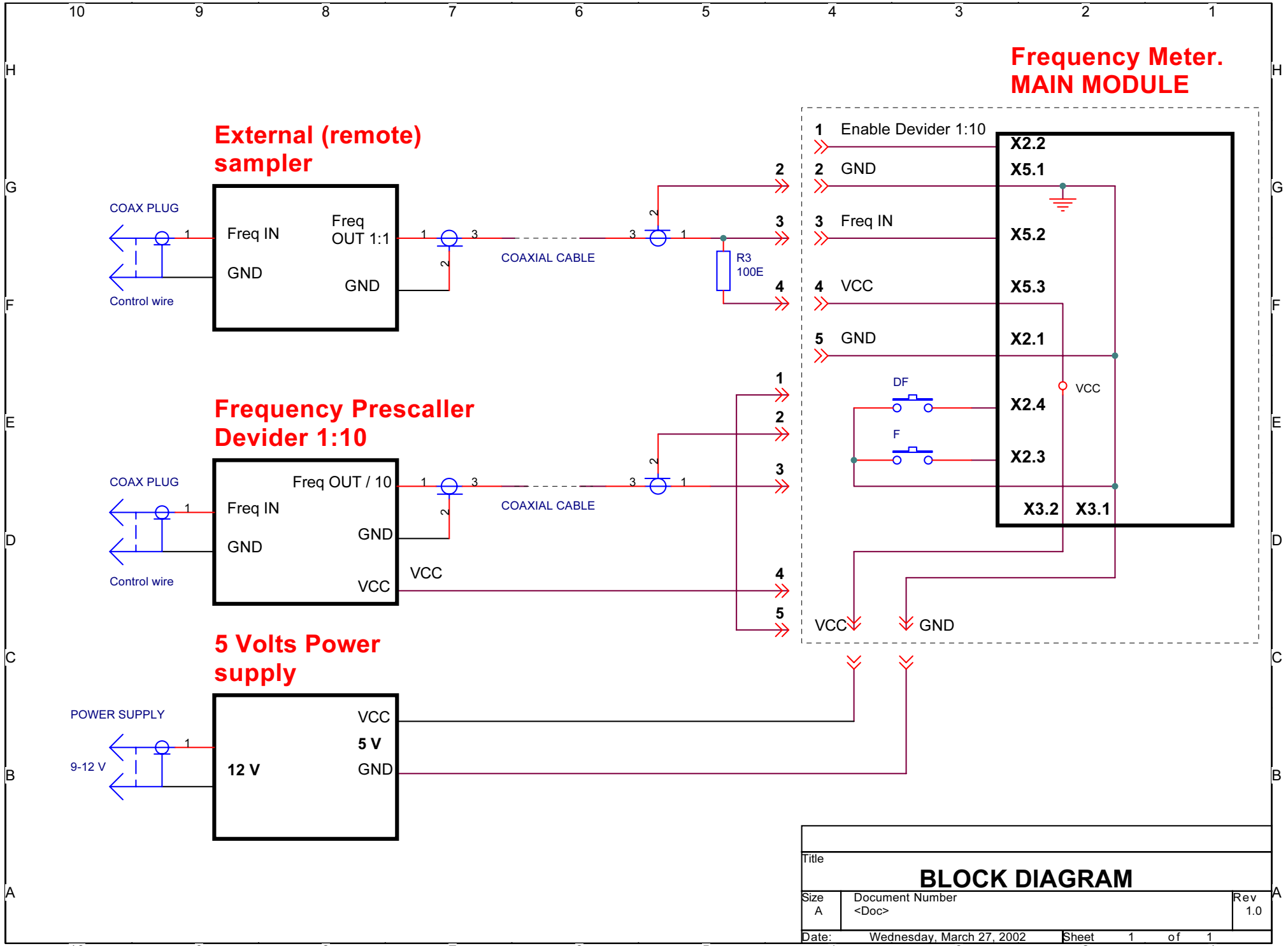
The entrance signal through condenser C1 acts on base of transistor VT1 (look Frequency Prescaller schematics) which strengthens an entrance signal up to a level necessary for normal work of microcircuit D1. Microcircuit D1 MC12080 (look at Motorola datasheet) represents a high-frequency divider of frequency which factor of division is equal 10. In view of that in used microcontroller AT89c51 the maximal frequency of accounting input (entrance) T1 f=Fqz/24 where Fqz – frequency of used quartz, and in frequency meter Fqz=6,144 МГц, the signal from a high-frequency divider acts on the additional divider of frequency representing decimal counter D4.

Lines dF and F (outputs 12 and 13 DD1) are connected to two buttons on closure without the fixing, installed on a front panel. The second contacts of these buttons are connected to a common wire. At short-term pressing dF button the frequency counter passes in the mode of measurement of instability of frequency. Thus on the indicator the difference between current value of frequency and that which was at the moment of transition in this mode is output. In high bit the sign of deviation of frequency is displayed, therefore the range of measurement of deviation is equal 10 MHz. At pressing F button the instrument comes back in the mode of measurement of frequency. This mode is installed and at powerup.

The line 1/10 (output 14 DD1) is connected to free contact of the entry plug. She(it) is intended for convenience of operation at usage of an external MICROWAVE of a divider on 10. On an answer part of the plug the cross connection between this contact and the contact connected to a common wire is put. Thus, at connection of an external divider on 10, expanding a range of frequencies up to 1000 Мгц this line incorporates to a common wire. Thus layout of decimal points on the indicator in appropriate way varies. By operation without the MICROWAVE of a divider, i.e. at measurement of frequencies up to 100 Мгц this contact should remain free. With an external MICROWAVE a divider the price of rightmost - 10 Hertz.

For support of electromagnetic compatibility an initial winding of the transformer it is desirable to make the electrostatic screen from a copper foil. It is possible to connect to the frequency counter and LED indicators practically any type for which to the right of digit are a point. It is better, if color of a luminescence will be red as light emitting diodes of other color consume the greater current in 1,5-2 times. On circuit given connection of indicators with the common cathode below is shown, For connection of the indicator with the common anode - simply swap chips - registers.

The important feature of the frequency counter is that in it is possible to use a quartz resonator on any frequency in a range 5. 12 Мгц. Optimal value 6. 8 Мгц, in my opinion, is.


Frequency Meter.
MAIN MODULE
External (remote)
sampler
COAX PLUG
Freq IN
GND
Control wire
Freq
OUT 1:1
GND
COAXIAL CABLE
R3
100E
1 Enable Devider 1:10
2 GND
3 Freq IN
4 VCC
5 GND
X2.2
X5.1
X5.2
X5.3
X2.1
X2.4
X2.3
X3.2
X3.1
DF
F
VCC
Frequency Prescaller
Devider 1:10
COAX PLUG
Freq IN
GND
Control wire
Freq OUT / 10
GND
VCC
COAXIAL CABLE
VCC
GND
5 Volts Power
supply
POWER SUPPLY
9-12 V
12 V
VCC
5 V
GND
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BLOCK DIAGRAM
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Wednesday, March 27, 2002
Sheet
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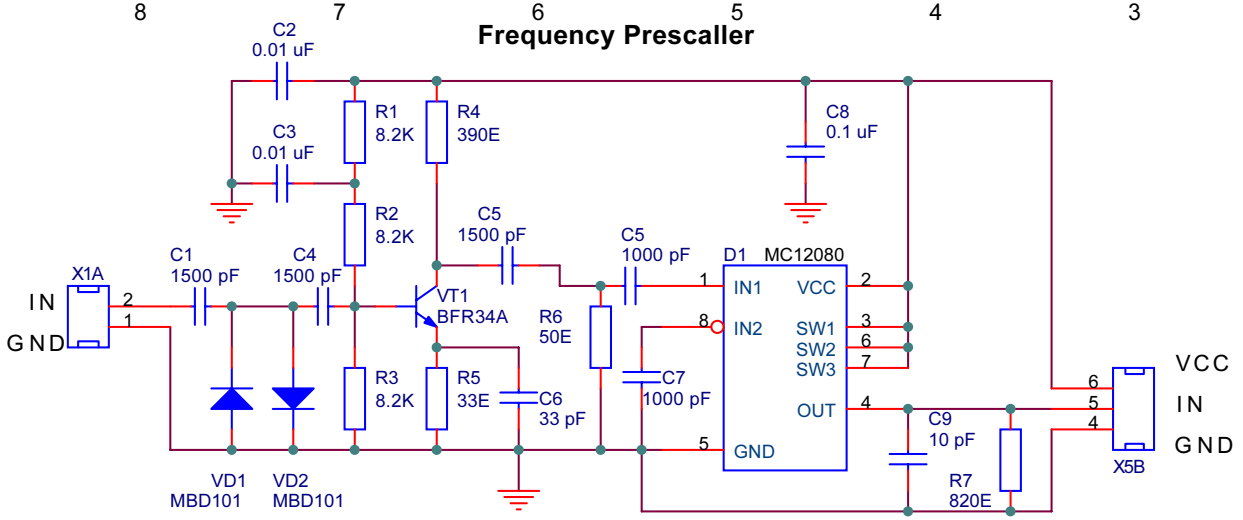
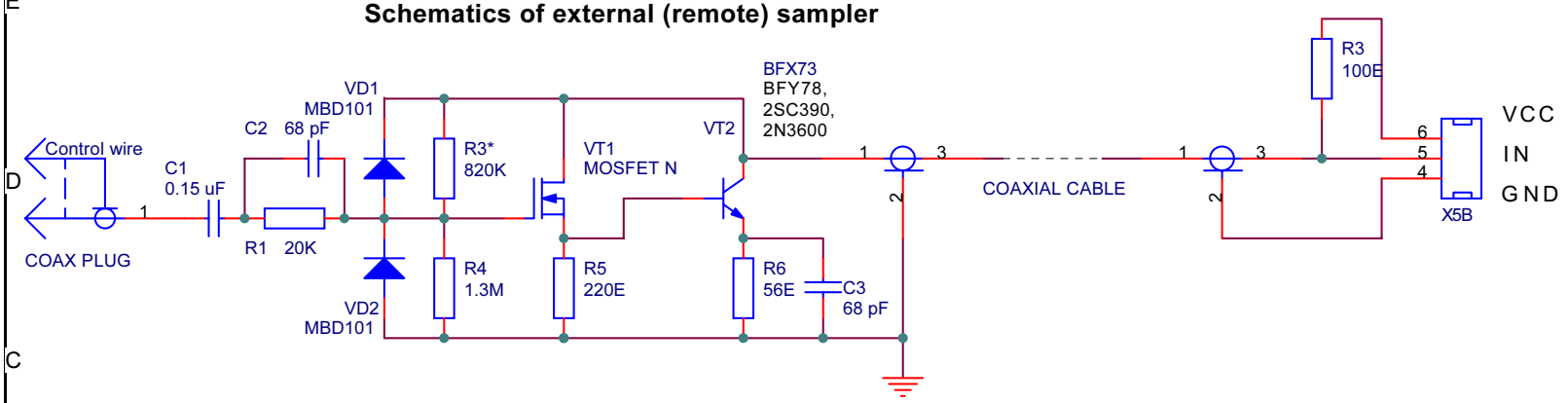
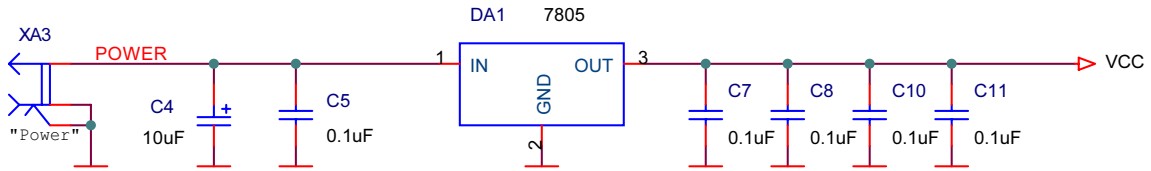
Frequency Prescaller



Schematics of external (remote) sampler



5 Volts Power supply



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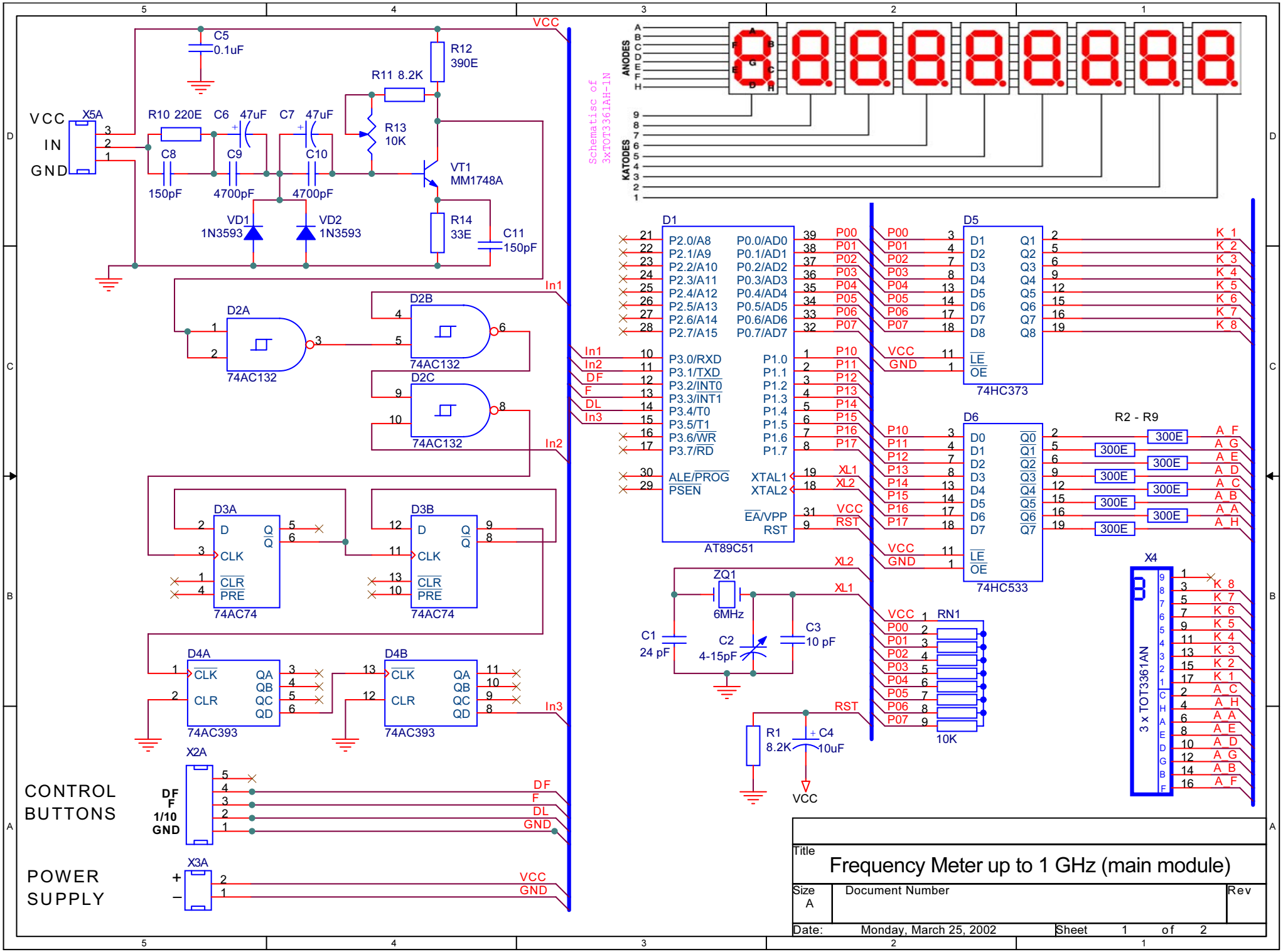
Date: Wednesday, March 27, 2002	Sheet 1 of 1	


VCC
C5
0.1uF
R12
390E
R11 8.2K
R13
10K
VCC
IN
GND
X5A
R10 220E
C6 47uF
C7 47uF
C8
C9
C10
150pF
4700pF
4700pF
VT1
MM1748A
VD1
1N3593
VD2
1N3593
R14
33E
C11
150pF
In1
In2
In3
DF
F
DL
GND
D2A
D2B
D2C
74AC132
D3A
D3B
74AC74
D4A
D4B
74AC393
X2A
CONTROL
BUTTONS
DF
F
1/10
GND
X3A
POWER
SUPPLY
+
−
VCC
GND
ANODES
KATODES
Schematisc of
3xTOT3361AH-1N
D1
AT89C51
P2.0/A8
P2.1/A9
P2.2/A10
P2.3/A11
P2.4/A12
P2.5/A13
P2.6/A14
P2.7/A15
P0.0/AD0
P0.1/AD1
P0.2/AD2
P0.3/AD3
P0.4/AD4
P0.5/AD5
P0.6/AD6
P0.7/AD7
P3.0/RXD
P3.1/TXD
P3.2/INT0
P3.3/INT1
P3.4/T0
P3.5/T1
P3.6/WR
P3.7/RD
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
ALE/PROG
PSEN
XTAL1
XTAL2
EA/VPP
RST
P00
P01
P02
P03
P04
P05
P06
P07
P10
P11
P12
P13
P14
P15
P16
P17
XL1
XL2
RST
ZQ1
6MHz
C1
24 pF
C2
4-15pF
C3
10 pF
R1
8.2K
C4
10uF
D5
D6
74HC373
74HC533
LE
OE
R2 - R9
300E
RN1
10K
X4
3 x TOT3361AN
K 1
K 2
K 3
K 4
K 5
K 6
K 7
K 8
A F
A G
A E
A D
A C
A B
A A
A H
Title
Frequency Meter up to 1 GHz (main module)
Size
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Date:
Monday, March 25, 2002
Sheet
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2

Duration of an interval of measurement is determined by two constants - К1 and К2. The program is constructed in such a manner that admits multiple correction of these values.

For adjustment it is extremely desirable to have possibility to take advantage of the factory checked up frequency counter. In the beginning it is necessary to measure frequency of generation of quartz in the given circuit(scheme). For this purpose the exemplary frequency counter connect through the capacitor 2-3 pF to output 18 or 19 DD1 (C3 - on the average position). As a last resort, at absence of the exemplary instrument, it is possible to accept for calculation value of frequency of generation of quartz from 1 kHz (for quartz 6 Mhz) up to 5 Khz (for quartz 12 MHz) above that on it is written. For example, for quartz 8 Mhz at calculation it is necessary to accept frequency of generation about 8002000 Hz.

Then we are set by value К1 in limits from 8 up to 16 and it is calculated К2.

$$К2 = 7 + 65536 * (К1) - f/12 ,$$

where f - frequency of used quatz, Hz.

К2 can accept value from 0 up to 65535, and К1 - from 1 up to 255. If K2 it turns out negative or more than 65535, we are set by other value K1 and we repeat calculation. And so until value K2 in limits from 0 up to 65535 will turn out. Obtained values K1 and K2 by rules of mathematics it is translated in the sexadecimal form. K2 it is necessary to approximate to the nearest odd value. Odd!

In authoring variant for f=6144600 Hz К2 = 12245 = 2FD5H, К1=8. Constant К1 is stored in cell 01B1H, high byte К2 - in cell 01B2H, low byte К2 - in 01B3H. Increase К2 on 1 will result in decrease of instrument readings on 10-20 Hz for измеряемой frequencies about 10 MHz (or on 1 - 2 Hz for frequency 1 MHz).

After start and adjustment of the instrument it is necessary to measure frequency of any generator and to compare indications to the exemplary frequency counter. This measurement should be carried out on frequency not less than 10 мгц. If not it will be possible to achieve identical indications rotation C3, it is necessary to correct values of constants К1 and К2. At usage of unitary programmed ROM it is necessary "to hammer" in cells 01B1H, 01B2H, 01B3H in zero, and values К1 and К2 to write, since cell 01B4H in the sequence which have been mentioned above. This operation can be spent multiply.

The frequency counter can be used not only on direct assignment, but also as " the New Year's souvenir ". Rate of execution of the program " the New Year's souvenir " is determined by constant K3 stored(kept) in cell 045AH. It settles up under the empirical formula:

$$К3 = 13,3 * F,$$

where F - frequency of used quatz, MHz

Special here it is not required to accuracy, the calculated value should be approximated to an integer and to translate in the sexadecimal form. For example, for F=12Mhz K3=0A0H, for 10Mhz - 085H, and for 6,144Mhz - 052H. In cells 045BH and 045CH for built - in ROM occurring "New year" is written in the binary-decimal form. The information in three listed cells can be adjusted, "hammering" in their zero and writing new values in subsequent. Only it is important to observe the order - K3, then 2 most significant digits of year and 2 low digits of year. Is admitted(allowed,valid) to adjust only year, leaving K3 constant.

At usage of the frequency counter on direct assignment the given program in any way does not show itself and is started, only if to include power supply at pressed "dF button. On the indicator in this case there is a year written in ROM. If to hold the button pressed more 2 sec, the score of years - 1997 starts, then 1998 etc. Having waited the necessary date it is necessary to release the button after that the program outputting on the indicator a little bit sequentially changed each other of dynamical pictures is started.

What? Make - will see!

Program (ch2.zip)

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Author of construction: **ra4nalr@write.kirov.ru**
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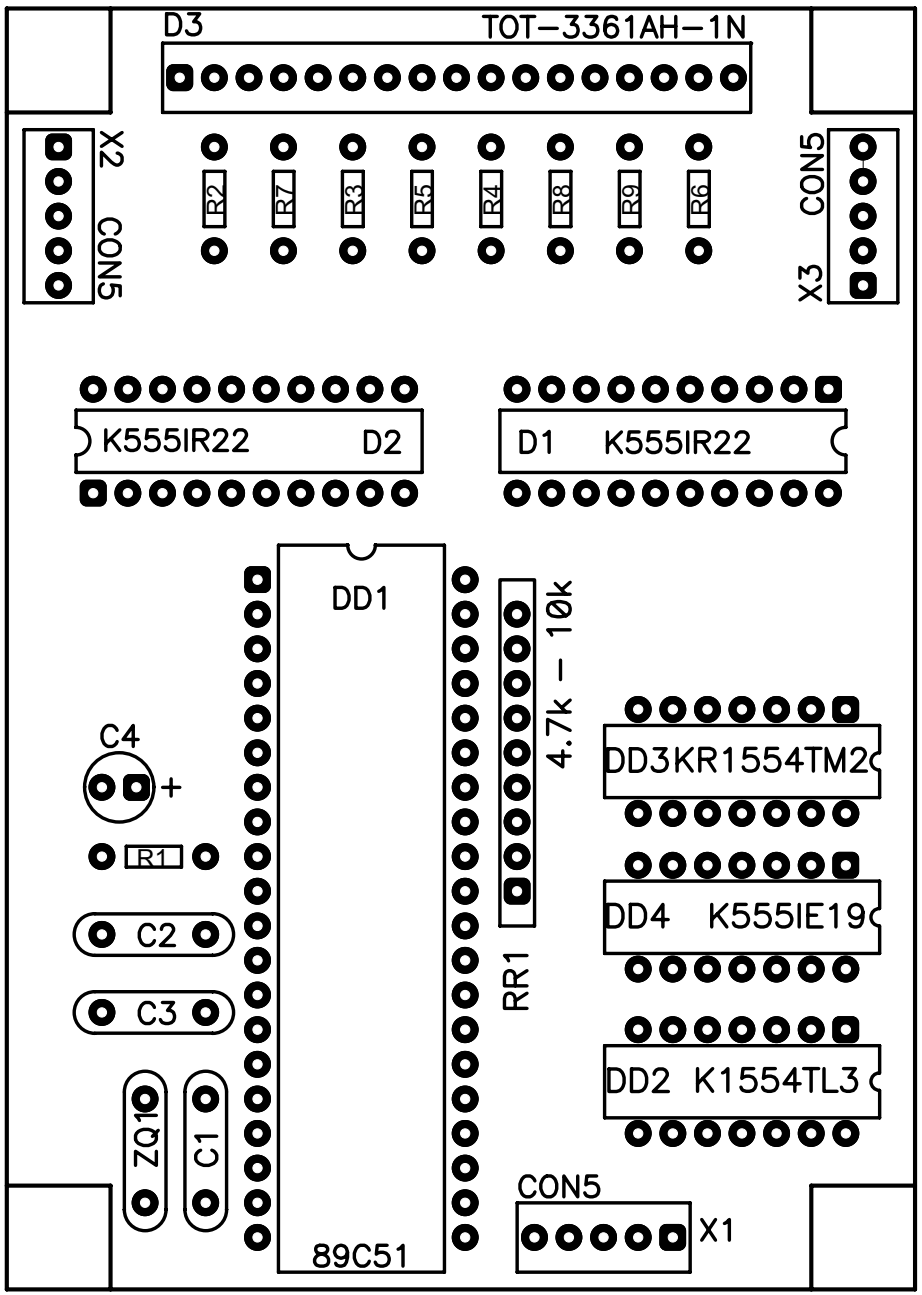
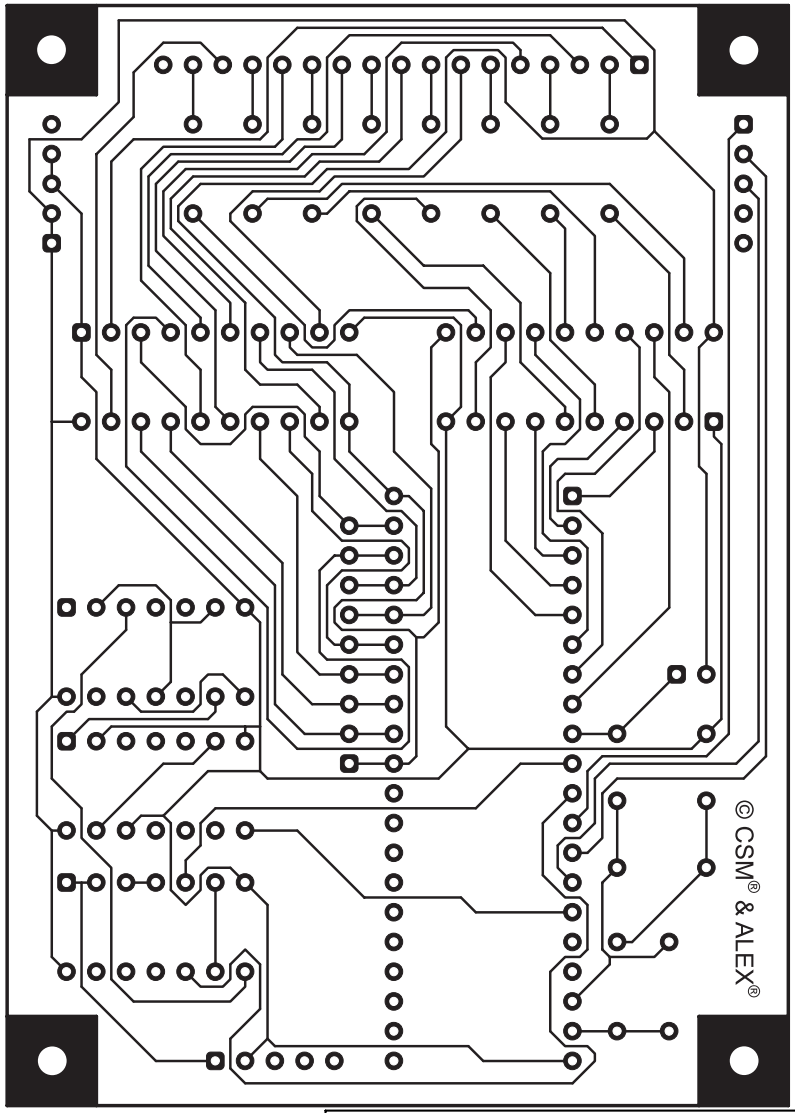
My LED matrix-indicator





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