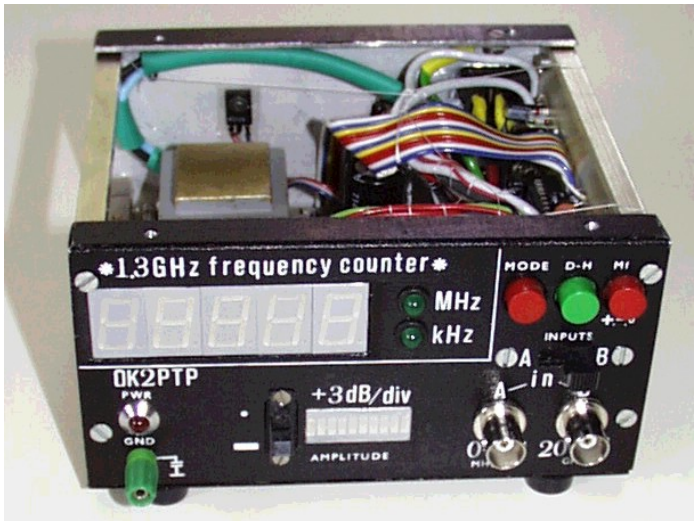
UNIVERSAL FREQUENCY COUNTER 1.3GHz

Vratislav Michal OK2PTP

Lately many articles in scientific literature deal with construction of an universal frequency counter. But the authors mostly think of frequency meter instead of frequency counter. We usually need something different than a measure apparatus in practical use. Various applications put to designer various claims. Basic tendency of this development was to fill up this free position with an easy, cheap but qualitative simultaneous device, which can work in wide spectrum of application without bigger change in the electrical circuit.



Technical parameters:

Frequency range:
10Hz – 1.3GHz
Basic frequency range:
0 – 2MHz
0 – 20MHz
with frequency divider:
20 – 200MHz
20 – 1.3GHz
Resolution:
5(5 1/2) dgt.
Wide spectrum action with IF, range, pulse counting….

As I said the apparatus was developed with respect to maximum flexibility and its chance of applying is from an easy meter by way of scale to AM – FM tuner, even to scale to radioamateur transceivers with many bands and atypical I.F., with a possibility to switch way of counting and auto range. Configuration can be set with DIP switch, in menu or by external logical circuits.

General description:

After resetting the apparatus rings three tones and says us that the resetting was made, internal EEPROM memory is read and the DIP switches are read. According to this configuration all the next actions of the counter will be controlled (besides some exceptions).

Frequency measuring:

The counter sets itself to this mode after the beginning of configuration. There are some functions in this mode: by pressing switch SW2 measuring stops and the last actual frequency – DATA HOLD – will be blinking on the display. We can change conversion of I.F. shift by pressing switch SW3 and in addition it enables a bigger resolution. Push switch SW1 to return.

The next functions are very important for installation of frequency counter to any application. You can set one fixed range with DIP2,3. DIP2 is lower range and DIP3 is higher range. This setting switches off auto range and is absolute after resetting.

You can set type of external frequency divider (decimal point) with DIP4. If the DIP4 is not switched, pin RB0 is activated as input pin and logical level on this pin you can set decimal point: for L frequency is displayed 1:1 (without external frequency divider) in kHz and for H is displayed 1:1 only with external frequency divider 1:100. For divider 1:10 (SW TCVR …) DIP4 must be set. This setting is absolute and logical level on RB0 has no effect.

Pulse counter:

The counter can cross to pulse counter mode by pressing switch SW1. Maximum pulse frequency is about 50kHz. This mode is indicated on display by legend:

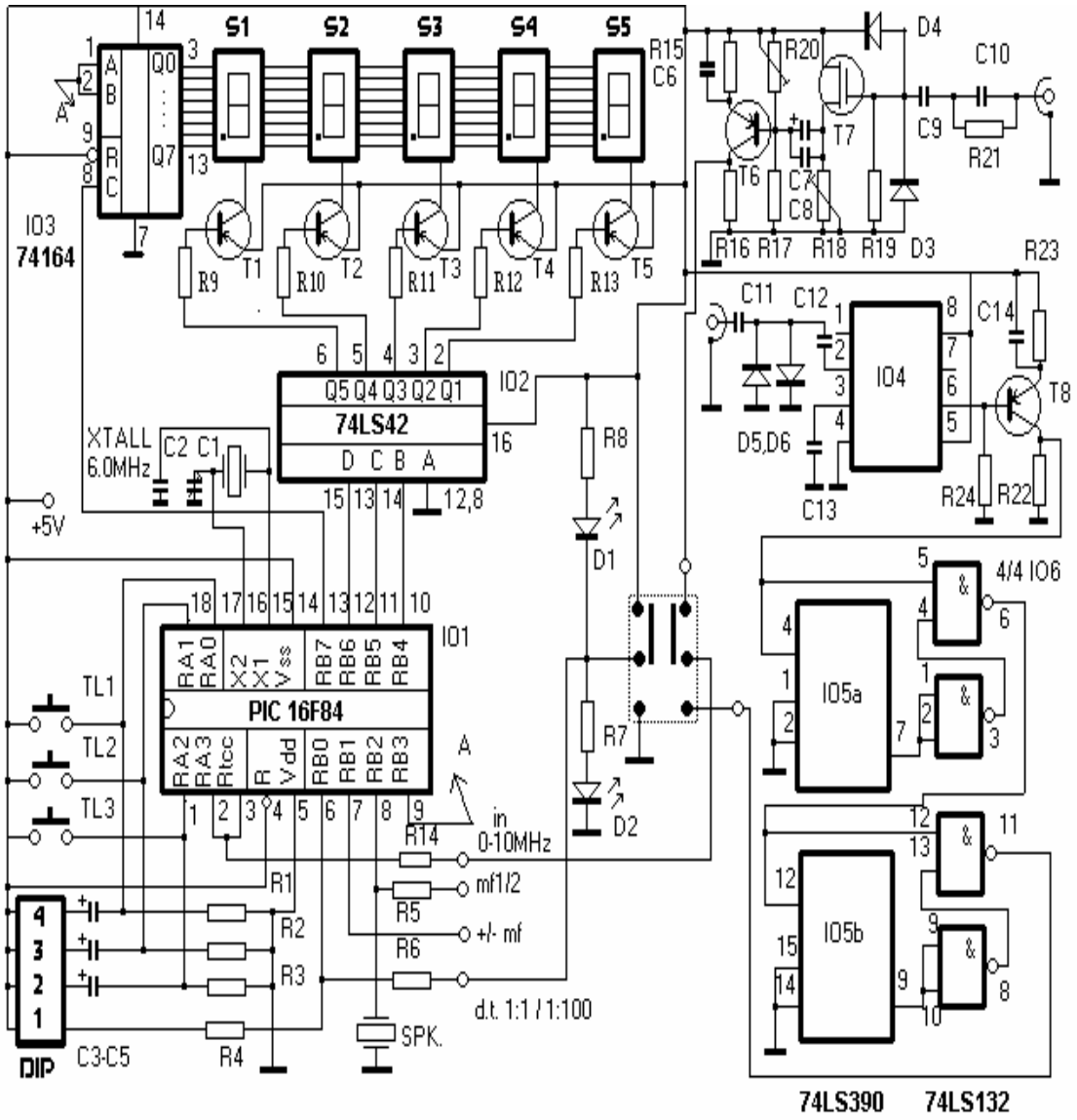
COUNT and it is thought as an additional function for application as laboratory frequency counter and could find exercise in work with logical circuit, wire coiling etc. Function DATA HOLD is implemented in this mode (it has a similar use as in frequency measuring) by pressing SW2 and real time display clear (SW3).

Setting mode:

The setting menu is open after the third stroking of the switch (SW1). It is indicated by legend

SET_F. If we don't push any other switch, we can return to frequency measure mode by the next pressing SW1. As we are supposed to use counter in two (four) decades, two I.F. frequencies (for each range) must be set. One for higher range and one for lower range. If you push

SET_F SW2 in setting menu then you can set IF frequency for lower range and by pressing SW3 for higher range. If switch DIP2,3 (auto range) is not set and we want to use counter in two



Obr.1 Schéma zapojení čítače

(four) decades (to use auto range) then we must be set on higher range frequency 10x lower than lower range. It means e.g. if we want to use IF 10.7 MHz we must set in lower range (SW2) number 10700 and in higher range 01070 (SW3). That is therefore, because the frequency counter doesn't calculate with this number as with frequency but only as with a number. Thanks to this kind of work the counter can do measuring in four decades, or it can work with two IF together. That is a great advantage for work with IF filter with atypical frequency or with out of tune filters. This function is "exotic" in other frequency counters. We can set it as on the clock. It means that we choose place value with SW3 and allocate the number with SW2. After complete settings push switch SW1, it carries out re-count from BCD to binar and this binar value will be written to destination address in EEPROM. The next menu is menu in which the conversion is chosen. You can set any IF Shift here. One of four modes of frequency shift is set by pressing SW3:

SUB: Decrement IF

ADD: Adding IF

PIN: Control (+/-) by external pin RB1

OFF: Conversion is off

Modes SUB, ADD, OFF set conversion after RESET. Mode PIN will allow to control across external pin IO1 RB1. If I have pin RB1 logical level H, then IF is added, and if I have level L then it is decrement. Not to reduce using of the frequency counter in two (four) decades, there is pin RB2 activated as input in mode PIN and one fix range (DIP2,3). It is possible to switch IF frequency, this pin must be connected to L or H (across resistance!!!) Overflow or bad decrement is indicated by legend ERROR with actual decimal point.

Example of application:

Scale for tuner VHF:

This application is the simplest one. In wiring diagram there is a skip input amplifier for Lf,

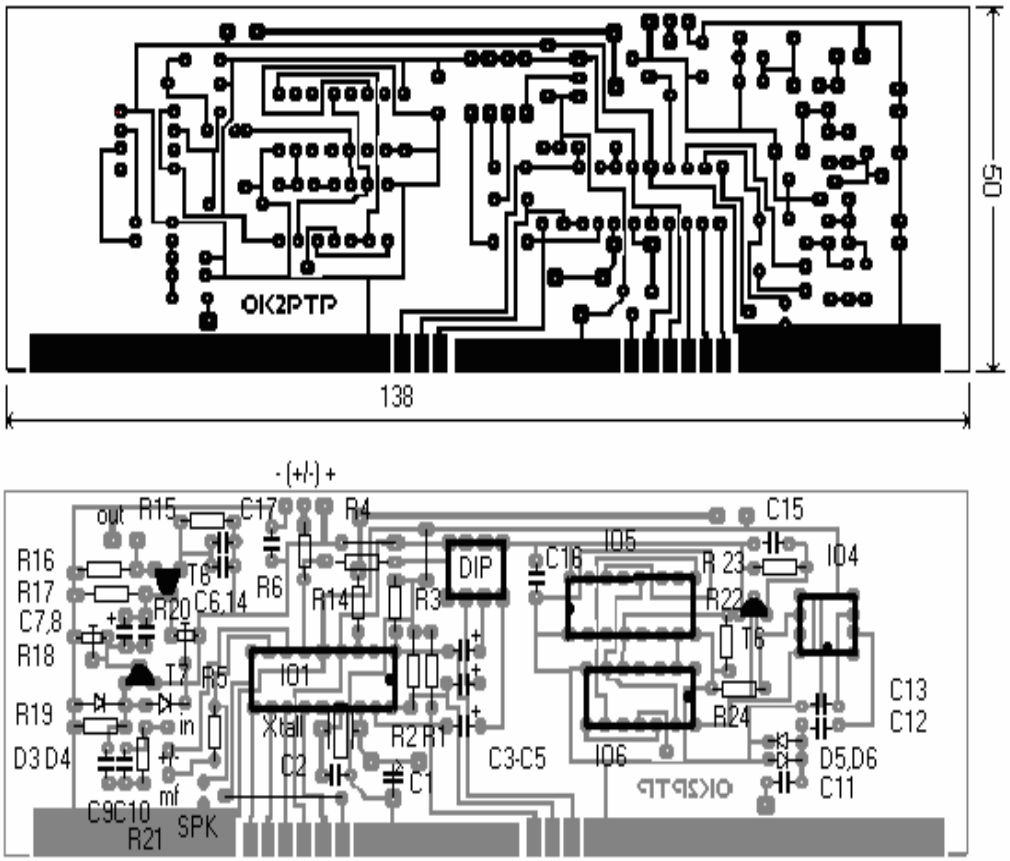
switches (setting by wire) and we can skip last section of display. It can be connected RB2 and amplifier input (mask crack in speaker). We put input of frequency divider together with oscilator coil (inductance connect). Then set DIP1 (decimal point for 1:100). If you don't measure in two ranges (100 and 1000MHz) set DIP3 for 1000MHz. Then set IF on the lowest range 10700 (type) and on higher range 01070. In the next menu we can set conversion SUB (type). That is the end of configuration and it will be actualized after every resetting.

SW Transceiver:
We use switching IF shift and auto range in this application. If you want to use frequency divider 1:10, set DIP4 for decimal point. Then set IF: 90000 (type) on lower range and 09000 on higher range. On band switch detail contact , this connect to H or L according conversion. As a divider you can use e.g.: 7490.

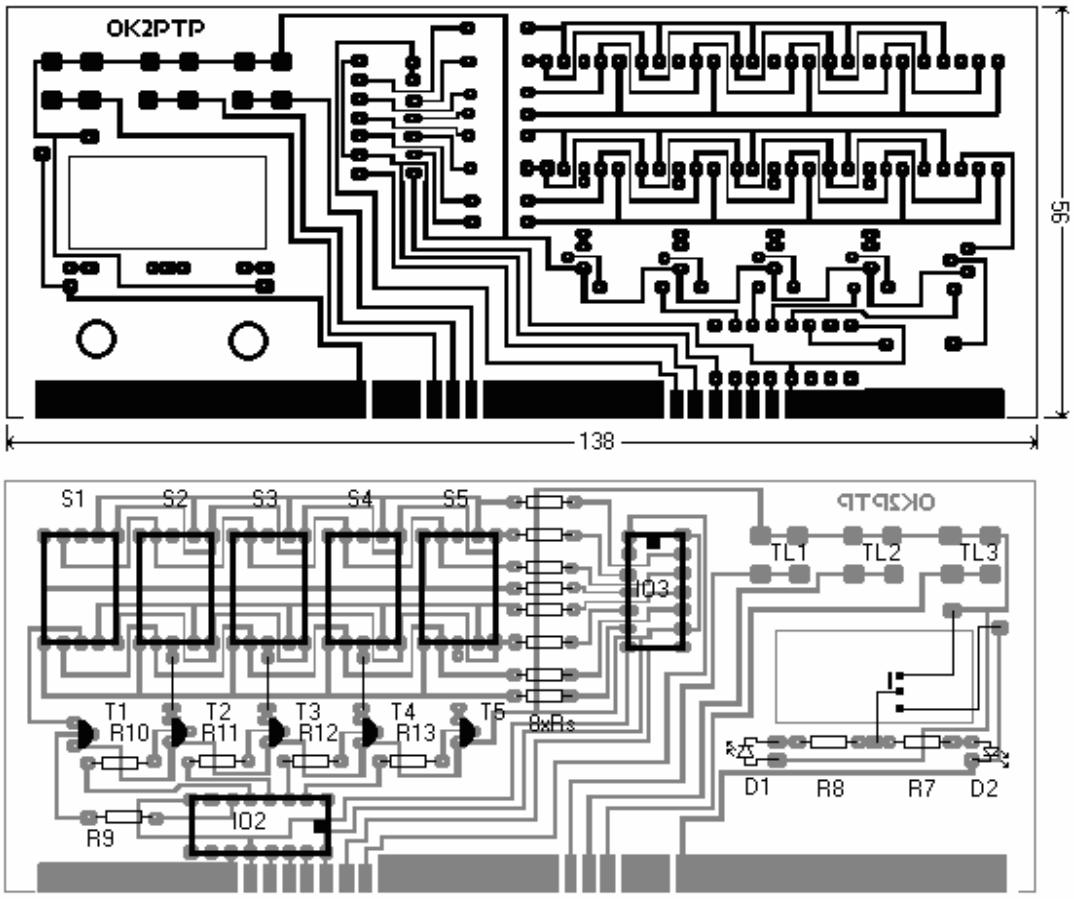
Tuner SW/WHF:
This application uses frequency counter in four decades. E.g. 88-108MHz and 550-1.6MHz. Set IF 01070 (type) on lower range and 00455 (type) on higher range. Set off auto range (set DIP3 for fixed higher range) and mode PIN. . Then connect decimal point controler pin and pin for IF switch (across resistance) and this connect to band selector (SW=L, USW=H).

Wire connect description:
This frequency counter is divided into two parts:
- Frequency counter
- Subvention circuits

The whole counter is controlled by IO1 uPC PIC16C84 by Microchip. This microcontroler works with crystal 6.000MHz. Except measuring it controls processor display, switch, input pins etc. As this microcontroler has absence of free pin, a seriál communication protokol between microcontroler and display was chosen. Shift register IO3 74164 is used as serioparalel convector. IO2 7442 is multiplexing one segment of all display S1-S5.
Capacitors C3-C5 together with DIP and resistance R1-R3 serve for configuration of the microprocessor IO1. After resetting capacitors are discharged across connected DIP and subsequently tested. Thanks to this we can make fast setting on reset by holding SW1-SW3 without setting DIP.
As the pin RB0, RB2 and RA3 are switched between input and output mode, they must be protected against short circuit by resistance R4,5,14.
Input circuits are switched on their output. Input amplifier is with transistor T6 FET and T7. Input gain is adjusted by R7, R8.
Frequency divider is of type ECL 1:64 SAB6456. (SDA4212,U664). Transistor T8 converses level ECL to TTL. Divide range is adjustment in divider IO4, IO5 (2x4:5) to 1:100.



Obr.2 Deska vstupů a procesoru



Obr.3 Deska displeje

LED, for indication actual input (actual unit kHz/MHz) are connected to section input switch which switches decimal point.
The whole counter is supplied by voltage 5VDC current cca 200mA.

Mechanical construction:
The counter is developed on two perpendicular boards. (picture 2, picture 3).
Adjusting:
The counter must work on the first attempt in error free construction. Adjusting can be done in familiar frequency in inputs pin. Flesh memory EEPROM is implemented in processor, producer warrants 1000 reprogramming . Factual life cycle is much higher. But in spite of this I recommend to set IF shift with discretion.

Component list:

R1,R2,R3 R4,R14,R17, R24,R21	**680R**
R5,R6,R9,R10, R11,R12,R13	**1K**
R7,R8,R16,	
R22	**150R**
R15,R23	**47R**
R19	**1M**
R20	**10K trimr.**
R18	**2K2 trimr**
C1	**0-30pF trimr**
C2	**30pF**
C3,C4,C5,	**2u2**
C6,C7	**47uF**
C8,C11,C12,	
C13,C14, C9	**M1**
C10	**47Pf**
D1,D2	**LED**
D3,D4	**KA206**
D5,D6	**BAT46**
T1-T6,T8	**KC636**
T7	**KF245**
IO1	**PIC16C84(16F84)**
IO2	**MH74LS42**
IO3	**MH74LS164**
IO4	**SAB6456 (SDA4212, U664)**
IO5	**MH74LS390**
IO6	**MH74LS132**
S1- S5	**SA56EWA….**
DIP	**4Xdip**
Xtall	**6,000MHz**

I can send reprogramming processor for the parties concerned in building (after transmission) (for the charge of postage) or SASE (envelope with stamp). But after setting I can send a new processor.

Vratislav Michal
Bezručova 4
OLOMOUC 77200
CZECH REPUBLIC
tel.: +420732166550