1999

BASIC-Tiger® with radio-controlled clock

Gunther Zielosko

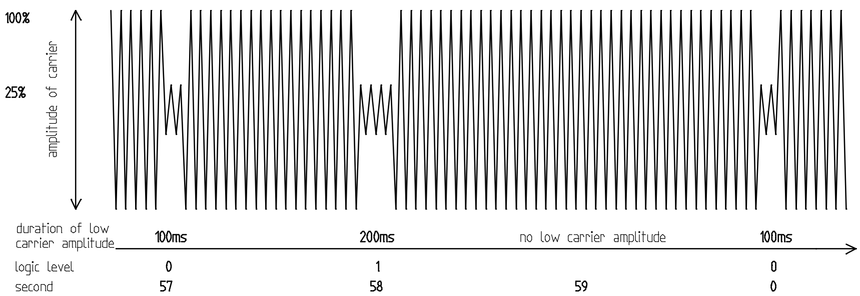
1. The technique of radio-controlled clocks

Since the development of radio-controlled clocks their extreme precision has been advertised, but one may ask: What do I need this for? Also the Basic-Tiger™ community surely doesn't need a clock with less than one µs divergence per year. The second advantage of radio-controlled clocks, to switch from summer time to winter time and vice versa automatically, isn't that spectacular that you want to throw away all old systems. So this is also done by the sample program TIMECVT.TIG, coming with the Tiger-BASIC™, without needing a RC clock.

But there is one invaluable advantage of the RC clock technique: It can be used to synchronize systems on power-up or by commands with the "official" time. It is our goal to develop a system with hard- and software that automatically or on request gets the official time into the BASIC-Tiger™, where it can be recalled.

At first some information about the basics of the RC clock technique.

The in Germany by radio transmitted time origins from an atomic clock, located at the "Physikalisch Technischen Bundesanstalt" in Braunschweig. The time information is send to a long wave transmitter (77,5 kHz, therefore the transmitter is named DCF77) in Mainflingen near Frankfurt/M, which transmits it amplitude modulated in coded form. This coding is done by following principle: In each second the amplitude of the sent carrier frequency is for a short time lowered to 25% of its regular amplitude (Pic. 1).



Pic. 1: Modulation of DCF77 time signal (not true to scale!)

In the length of the lowering information is "hidden", 100ms lowering means logical 0, 200ms means logical 1. So almost 60 bits can be placed into one minute. Every second has a certain meaning in this "time telegram". Details about that time information can be found e.g. in the book "Messen, Steuern und Regeln mit dem BASIC-Tiger® System" by Bernd vom Berg and Peter Groppe and in other sources. The 59th second of each minute has a special task. Here the carrier isn't lowered at all, so that it is possible for the receiver to synchronize itself to the start of the minute, so when there is "nothing happening" for 2 seconds, a new minute starts and with it a new counting of the time bits. Additionally to the general time information further bits are transmitted, signalizing e.g. summer time, time zone information, announcement of leap seconds, information about the antenna etc. Also important are parity bits, which are used to check the received data for errors.

All in all a perfect system, but there are nevertheless some hidden weaknesses. So the transmitter Mainflingen can be received throughout Central Europe, geographic and architectural characteristics (Ferro-concrete) not always enable undisturbed reception. Additional problems are created by electromagnetic interference. Especially TV sets and computers often prevent a stable receipt, as they emit frequencies that disturb the receiver of the RC clock. A breakthrough in this matter came with the fact that all modern RC clocks are really quartz clocks, which are only synchronizing themselves at certain times with the DCF77. If the reception is bad, e.g. simply another hour is waited and until then the quartz time base is used. Sometime at night all TVs and computer are turned off and even under difficult reception circumstances a synchronization is done. This is exactly how our solution is supposed to work, we want to synchronize the BASIC-Tiger™ clock once and then let it run by itself.

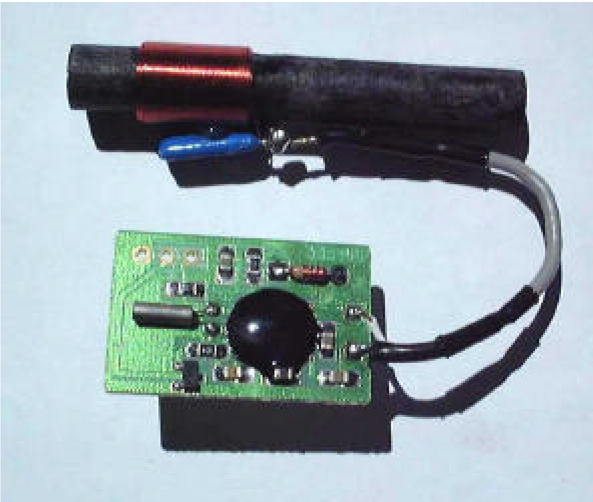
2. The circuitry

The core of our RC clock addition is a miniature receiver which already contains all necessary parts including ferrite antenna. Such a module (Pic. 2) is available e.g. from

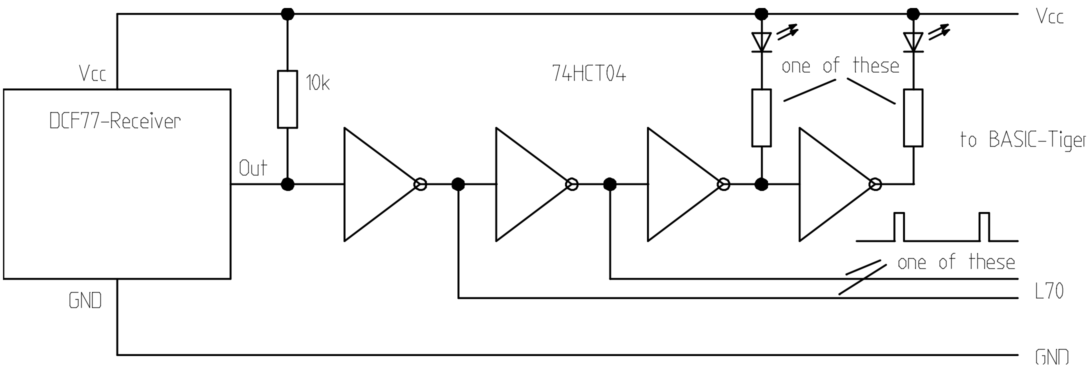
ELV Elektronik
Postfach
26787 Leer   Tel.: 0491 / 6008-316   Internet: http://www.elv.de

for just a few Euros (Order no. 50-352-62). The there offered module just has to be connected to the supply voltage (1.2 to 5V) and then supplies at its output the demodulated DCF77 signal. We connect the module with its appropriate connectors to GND, Vcc of the BASIC-Tiger™ and the output to Tiger pin L70. Although the Tiger's inputs are already pulled up, at the output an additional 10 kΩ resistor to Vcc should be inserted, to ensure a stable recognition of the high level.
To make it optically more appealing, a LED should show the pulsing time telegram, that requires a gate IC 74HCT04. What LED is used and what output line is connected with pin L70 of the BASIC-Tiger™, depends on if the DCF77 module gives out high or low-level during the blanking interval. We need short high-impulses on L70 and so the LED should light up shortly, which surely can be found out by testing.

With this small additional assembly we have all we need:



Pic. 2: DCF module from ELV



Pic. 3: Connection of DCF77 module

With the following program that is how it works:

After switching on the BASIC-Tiger™ first first the key Q is asked for. If it is pressed, line L70 is read and the incoming pulses are analyzed (LED1 blinks in second rhythm). If you want you can surpass the keyboard request with a small program modification and for example perform a synchronization with the DCF77 transmitter on every system restart. As this maybe in the middle of a minute, it must be waited for at least one complete pass (1 minute). We opt for safety and wait for 3 passes. Only when these are received correctly in a row, the time is taken over in the BASIC-Tiger™. From there the Tiger counts up its seconds internally, the DCF77 program routine is exited.

3. The program

The program DCF77_01.TIG is generally a combination and modification of two complex programs. The first, TIMECVT.TIG, is a collection of routines for time conversion and origins from the examples coming with the Tiger-BASIC™ software from Wilke Technology. The other, P5.TIG, origins from the software collection of the above mentioned book “Messen, Steuern und Regeln mit dem BASIC-Tiger® System”, in which a lot more about the topic DCF77 is said. Each of the original programs is a solution for only a part of our task. P5.TIG “solves” the time telegram, disconnecting the receiver leads to loss of the time. Passing the time to the internal BASIC-Tiger™ clock is not done. TIMECVT.TIG only allows the conversion of different time formats amongst each other and enables read and write access to the internal BASIC-Tiger™ clock. The problem here is the complicated input of the time. The program DCF77_01.TIG merges both programs and enables a comfortable dealing with the time in BASIC-Tiger™.

A few more words about starting up hard and software. Depending on the DCF77 receiver module some adjustments may have to be done. Some modules in the blanking time (100 resp. 200 ms) have a low level on their output, others have high level. The program DCF77_01.TIG expects high level! The layout of the circuit allows both variations by choice of the output. With an oscilloscope or with the LED you can find the correct variation. The high phase of the output signal for pin L70 must in regular operation be shorter than the low phase!

The users should consider that because of receiver module tolerances or bad reception conditions the receiver needs some time to recognize the signal changes. Therefore it may occur that high time to analyze on L70 gets to short. Ideal would be e.g. 100 ms (at logical 0), the program checks with lower limit 80 ms, but in reality only 70 ms are reached. So this impulse is rejected and the program dutifully exits the evaluation (“Sorry, no synchronization...”). When the LED in our circuitry blinks stable with short and a bit longer impulses, but still no synchronization is done, we can “save” s.th. by software. In the (original) program in the lines 405 to 415 the valuation of the high impulse length is done:

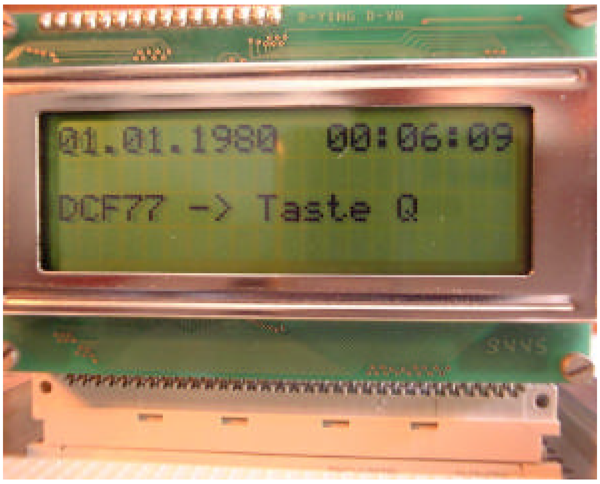
```
IF ((TAKT_TICKS<=80) OR &                                 ' Evaluation of HIGH
       ((TAKT_TICKS>=120) AND (TAKT_TICKS<=180)) OR &     ' impulse length
        (TAKT_TICKS>=220)) THEN
      SYNCRON=0                                           ' Impulse length outside tolerance,
      ELSE                                                ' therefore synchronization lost!
        IF (TAKT_TICKS > 80 AND TAKT_TICKS < 120) THEN
          DATEN_BIT=0                                     ' Impulse length for log.0 signal
          ELSE
            DATEN_BIT=1                                   ' Impulse length for log.1 signal
        ENDIF
    ENDIF
```

Here you can with (careful) modifications lower the minimum length for logical 0 from 80 to e.g. 60 and the minimum length for logical 1 from 180 to e.g. 160. With this trick it should work. On difficult reception conditions it is good to keep the receiver at a distance from BASIC-Tiger™, PC and TV.

The following pictures show several “snapshots” of the LC display when running the program.

1999

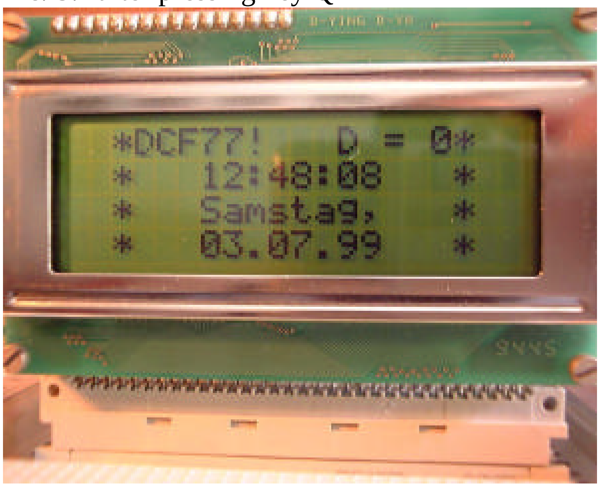
Have fun with your own atomic clock!



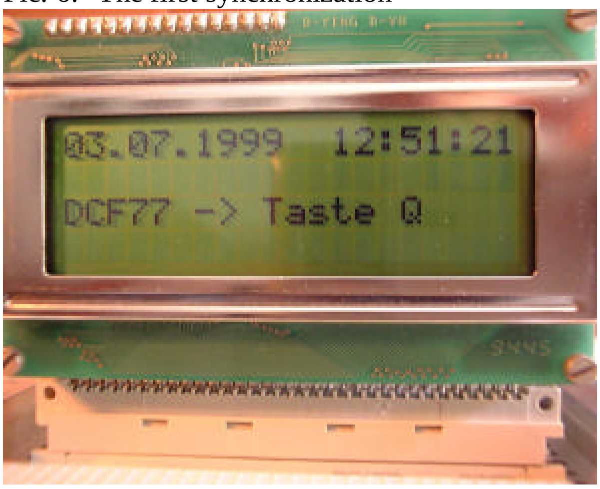
Pic. 4: BASIC-Tiger™ with “internal” clock

Pic. 5: after pressing key Q

Pic. 6: The first synchronization



Pic. 7: The fist pass (0) was successful



Pic. 8: BASIC-Tiger™ runs, now with “official” time