10 MHz OCXO Clock for the hpSDR-Transceiver built up with TAPR-boards MERCURY, PENELOPE, OZYMANDIAS, and ATLAS-EU

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To improve the frequency stability and accuracy of the hpSDR system (1), an external clock source was built up based upon the OCXO model AXIOM30-12-05 made by the German AXTAL company (2). No further software frequency correction is necessary anymore. In General -> Calibration of the KD5TFD or W5WC modified PowerSDR software Set-Up the frequency correction factor has been set to 1.0 resulting in zero beat with „Deutsche Welle“ on 6075 kHz and most commercial broadcast stations received. Comparison with a Rb atomic frequency standard (3) shows that the frequency stability obtained is indeed of the order of several 10^{-9}. Software Set-Up selection: 10 MHz Clock Source: Atlas, 122.88 MHz Clock Source: Mercury.

The hpSDR transceiver consisting of MERCURY, PENELOPE and OZYMANDIAS has been built up in a most compact way on a 3-slot ATLAS-EU board fabricated by Gerd, DJ8AY. Since no space was fore-seen for EXCALIBUR (4), the solution described below has been developed to integrate a highly stable clock-source onto the ATLAS board.

The AXIOM clock source used is shown in Fig. 1. It needs 12 V of supply voltage and has a current consumption of about 60 mA in steady state and about 180 mA during the first 2 minutes of warm-up time. Output voltage is 5 V_{pp} HCMOS with 50% duty cycle. Slight frequency corrections of about +- 10 Hz are possible using an external potentiometer (see Figs. 3 and 4).

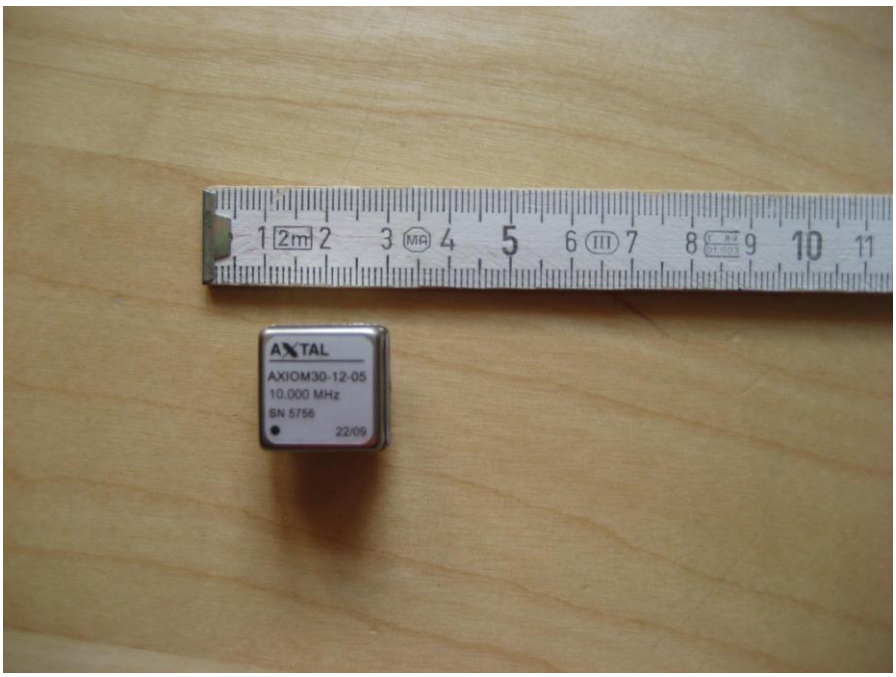


Fig.1: *The oven controlled low phase noise 10 MHz quartz oscillator model AXIOM30-12-05 by AXTAL. Current consumption is 180 mA during warm up, 60 mA in steady state phase. Output is 5V_{pp} HCMOS.*

The source has a high frequency stability. Expressed in terms of the Allan deviation σ for 1 second integration time, $\sigma(\tau=1) = 5x10^{-12}$. Phase noise is very low as well. It is plotted as function of frequency in Fig. 2.

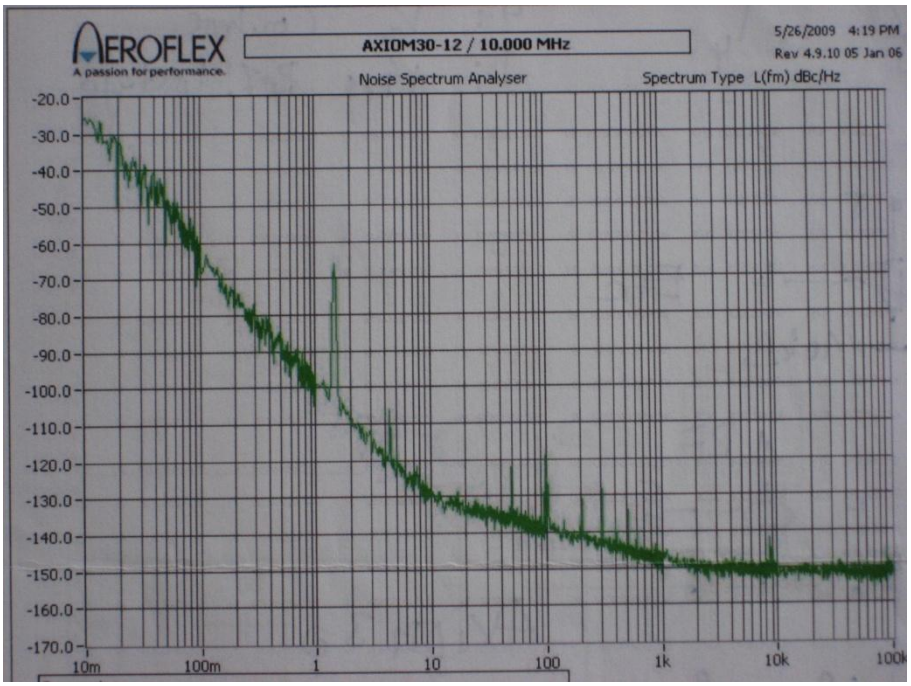


Fig.2: *The phase noise as function of frequency (5) for the 10 MHz OCXO type AXIOM 30-12-05.*

To gain sufficient space for the OCXO together with the necessary subsequent driver amplifier the ATX connector on the ATLAS board has been removed. Placing a small printboard carrying these components right on this place, allows for short connections to both pin C16 on ATLAS where the clock pulses need to be fed in and to the 12 V supply voltage. Fig. 3 shows the board mounted on ATLAS-EU.

The clock pulses needed at C16 of ATLAS should have3 V_{pp} with rise and fall times clearly below 10 ns and should be provided by a low output impedance source (6). The integrated circuit 74LVC244 is used. It needs no additional external components. Fig. 4 shows the circuit realized on the small board whose layout is shown in Figs. 5.

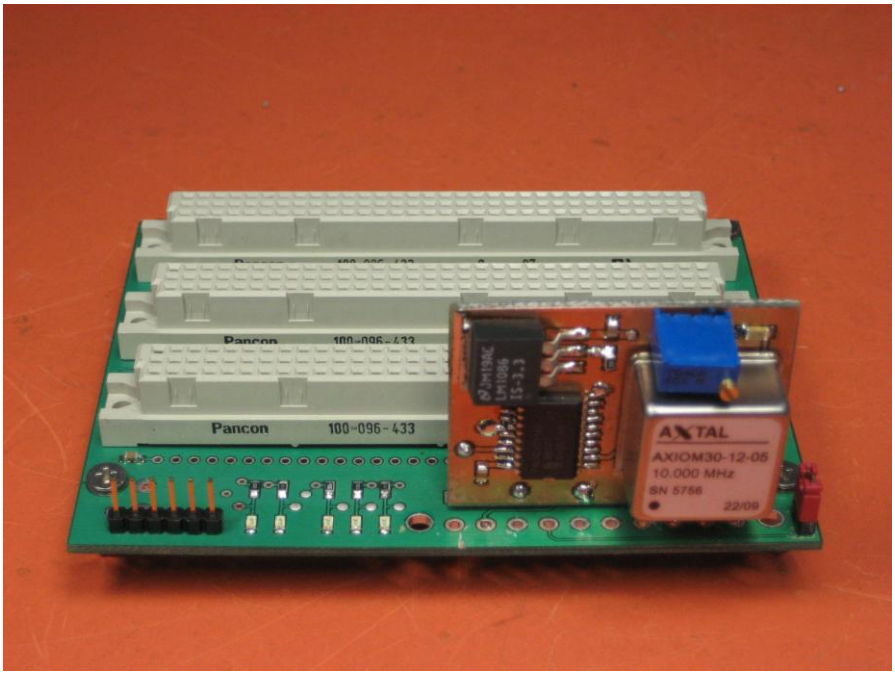


Fig.3: *The printboard carrying the 10 MHz OCXO and the 74LVC244A/SO driver amplifier to the left of it. In the upper left is a 3.3V regulator supplying the driver. Connection to C16 on ATLAS is made with a short wire right behind the left edge of the board (Fig. 8). The blue trim potentiometer on the upper right allows for frequency control of the OCXO.*

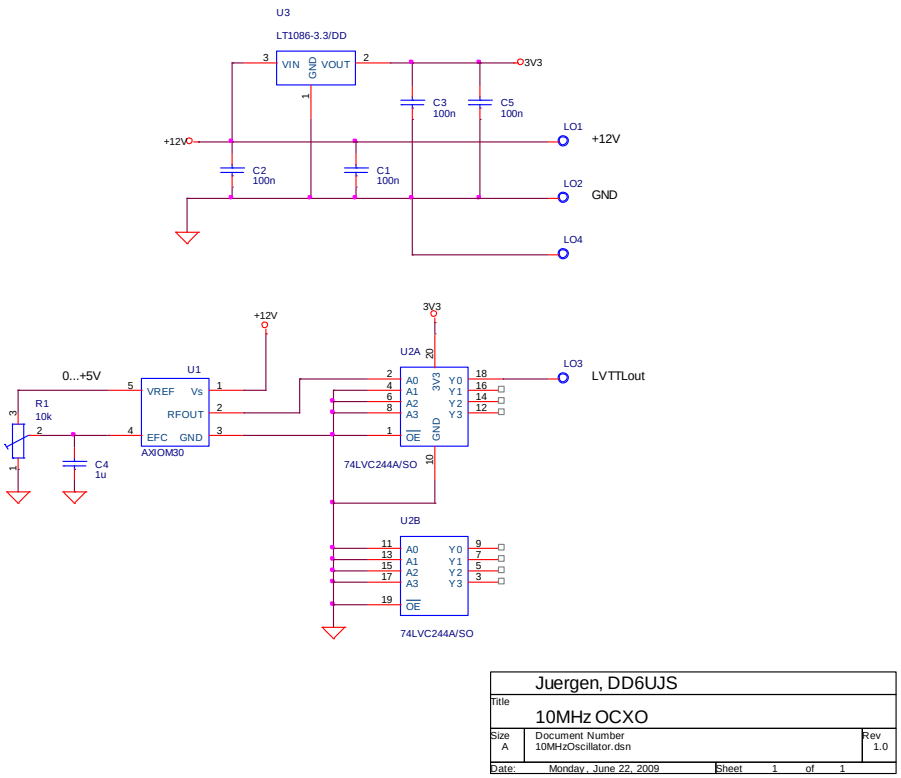
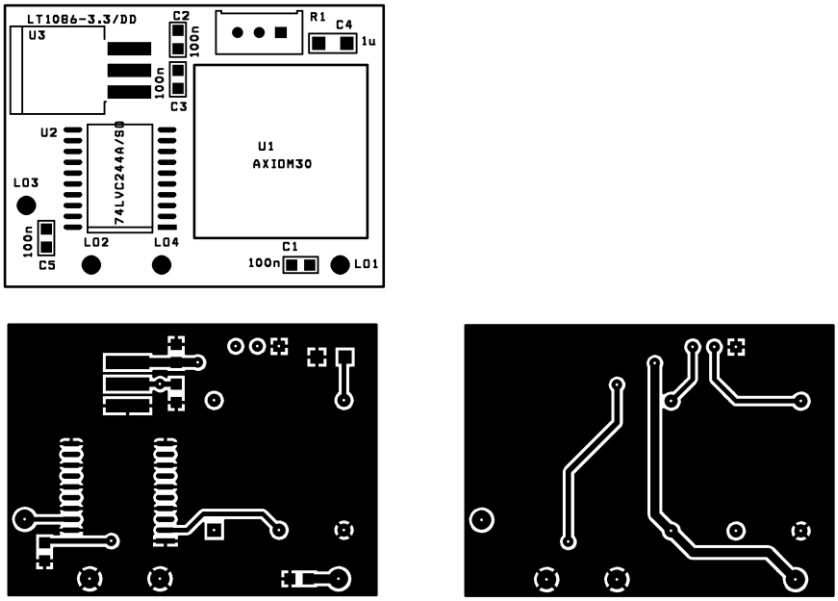


Fig.4: *The circuit of the external clock accessory. Upper half: the 3.3 V regulator; lower half: the OCXO at the left with the external frequency control potentiometer and the 74LVC244A/SO driver stage to the right.*



Figs. 5: *The layout of the circuit as given in Fig. 4.*

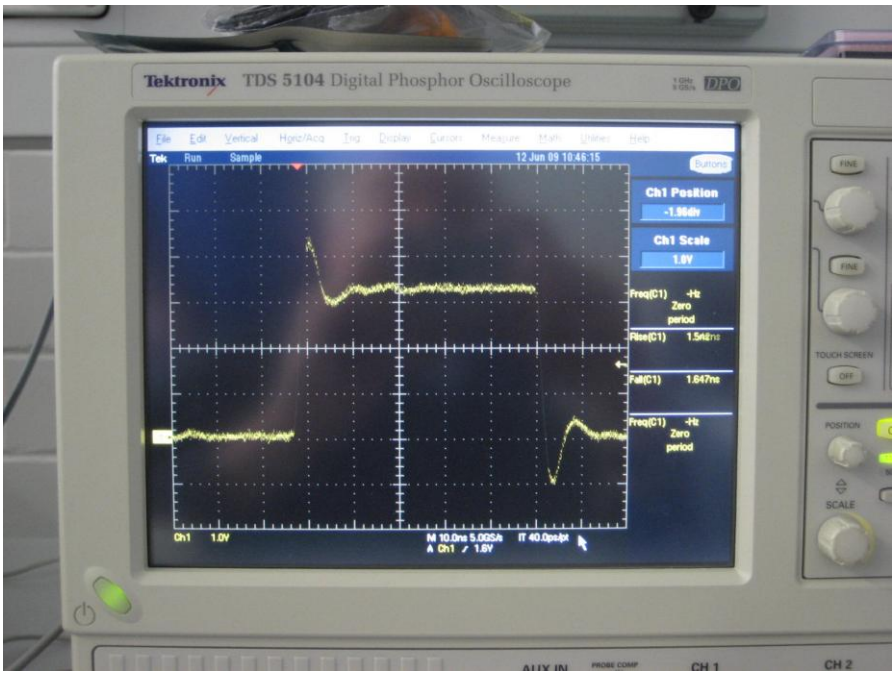


Fig.6*: An oscilloscope photo of the 74LVC244A driver output. Horizontal: 10ns/Div, Vertical: 1V/Div. The overshoot almost completely disappears with the output connected to C16 and the 3 boards installed. Clock pulse 10 to 90% rise and fall times are about 3 ns.*

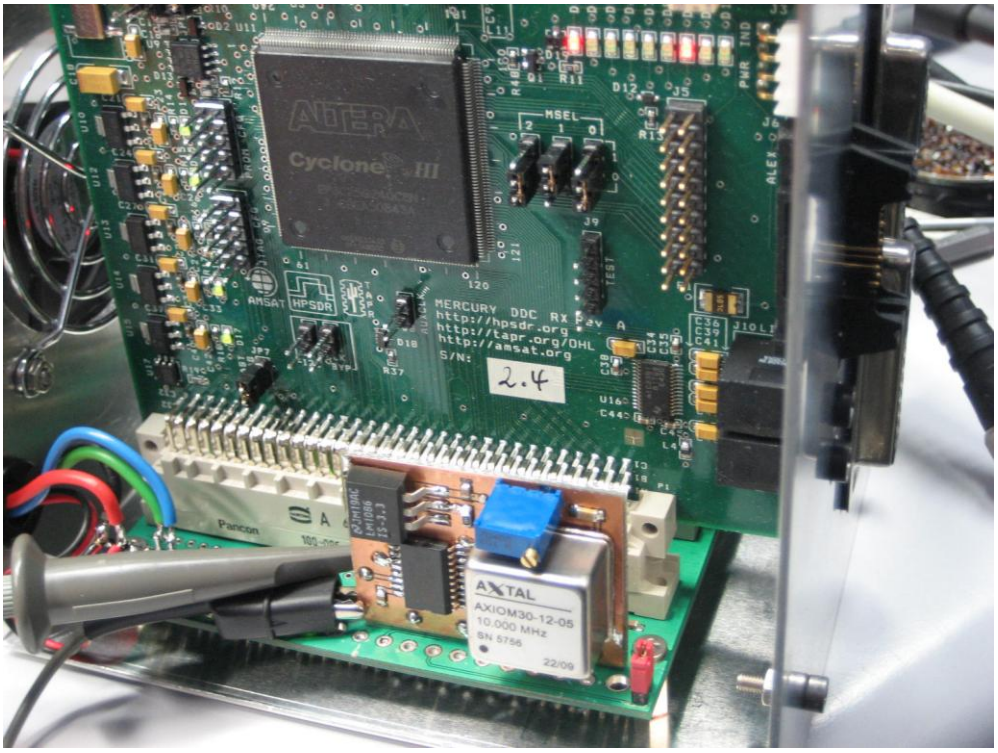


Fig.7*: The clock board on ATLAS and all other boards assembled (MERCURY in the background) during clock pulse measurements with the probe tips connected to the output.*

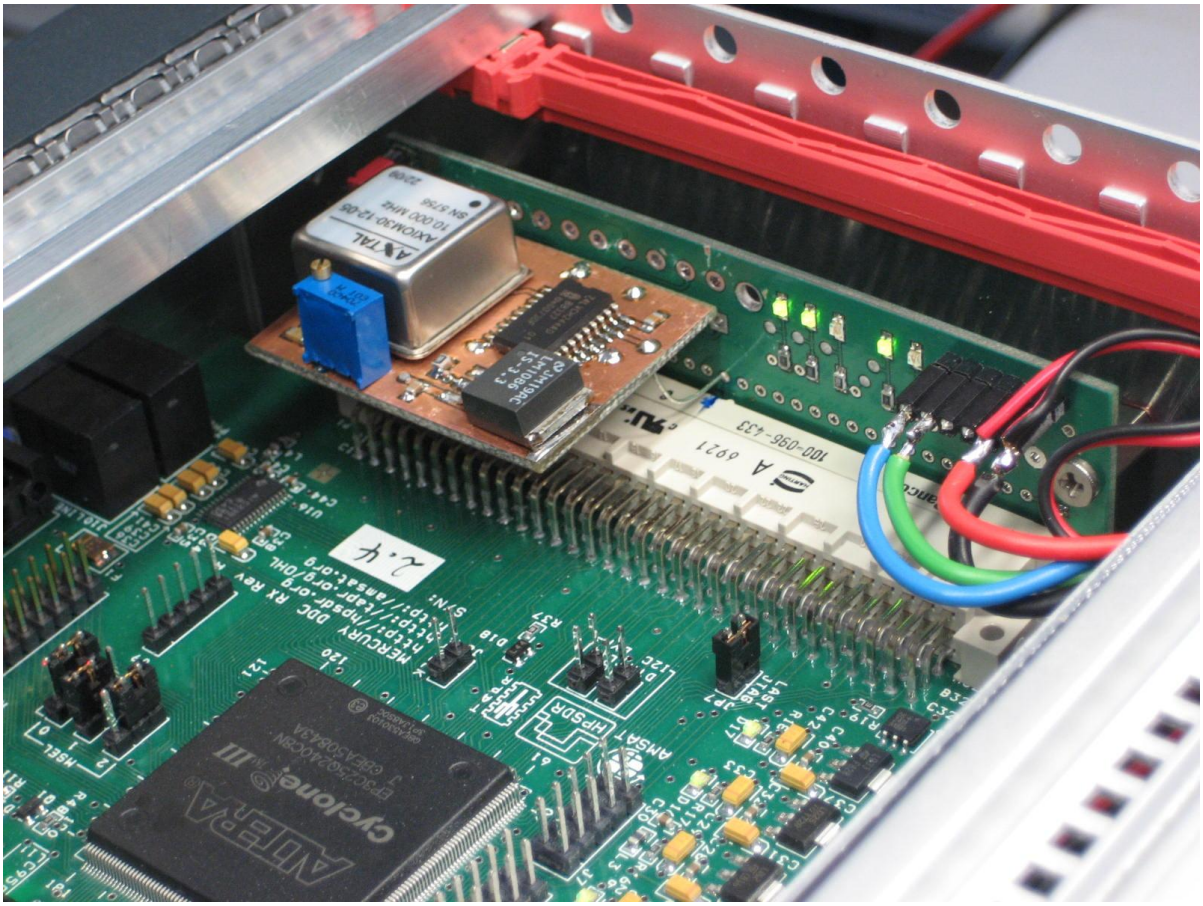


Fig.8*: All boards installed into the hpSDR cabinet which contains in addition the linear regulated necessary power supplies (+12V, -12V, +5V) and a 10W class-A driver amplifier following PENELOPE. Connection to C16 of Atlas is done with the non-isolated wire at the lower right of the small printboard.*

References

(1) DL2MDQ, “Assembly of hpSDR transceiver”, psr109, 4 (2009)

(2) AXTAL, Wasemweg 5, 74821 Mosbach, Germany

(3) Rb-standard used: LPRO-101 module from DATUM/Efratom

DL2MDQ, DD6UJS, “Rb Frequency Standard in the Ham Shack”, psr110, 16 (2010)

(4) See: http://openhpsdr.org/excalibur.html

(5) Individual phase noise measurement of the purchased unit provided by company

(6) Graham, KE9H, private communication