Tokenblauser:

Description of the schematic diagram and DIY hardware modifications

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In this application note, the schematic diagram of the Tokenblauser GPSDO is described. Since the Tokenblauser is also a platform for experiments, possible hardware modifications are suggested.

Block diagram

The Tokenblauser consists of the following subsystems:

- DC-DC switching regulator which produces intermediate voltage, V_INT;
- GPS module, generating TIMEPULSE signal;
- OCXO + DAC module, generating stable 10 MHz signal;
- Time Interval Counter (TIC), which measures the phase difference between TIMEPULSE and 10M_BUFFERED;
- 4xClock generator, which converts 10M_BUFFERED to four arbitrary frequencies;
- MCU module;
- Keyboard and Display board.

Switching regulator

The regulator converts input of 9…12 V to the intermediate voltage, 6 V.

Test points:

- TP1 – check the +6V here

Jumpers:

- JP1 – cut the traces to disconnect the regulator from the rest of the circuit

Connectors:

- J1 – standard barrel power connector for external power supply
- J3 – connected in parallel to the input DC socket
- J2 – get +6V from there

GPS Module

The main purpose of this module is generating a TIMEPULSE (1 PPS) signal. The GPS module is battery backed-up, and is connected to the MCU via serial port.

Modifications:

- Install other types of pin-to-pin (almost) compatible GPS modules. See the notes at the bottom left corner of the sheet.
- Install an additional power regulator for 5V GPS antennas. See the notes at the bottom left corner of the sheet.
- Install LED (D7) and resistor (R48, 470R) to monitor the TIMEPULSE signal.
- Connect USB to u-blox modules using TP47 and TP48.
- Connect the GPS module to the MCU via I2C (add R70, R72 – 0…100R)

Test points:

- TP44, TP45, TP46 – check the power supply voltages
- TP47, TP48 – USB connection for u-blox modules
- TP49 – check the antenna power supply (+3.3V or +5V)
- TP50 – TIMEPULSE (1 PPS) signal

Jumpers:

- Cut the traces at JP4, JP6, JP7 to connect an external GPS module
- JP3, JP5 – cut the traces to connect an external power supply to the GPS antenna

Connectors:

- J18 – SMA external antenna connector
- J17 – use to power up an external GPS module

OCXO + DAC Module

This module generates a stable 10 MHz signal. The DAC is used to control the frequency. The OCXO is powered from its own 5V linear regulator. The DAC is connected to the control voltage input of the OCXO via the resistor network, which includes the potentiometer RV1. The DAC, as well as buffer circuits, are powered from own linear regulators.

Modifications:

- Add sinewave output of the 10 MHz signal (instead of the square wave output) – remove R55 and install an L-C filter you like, using unpopulated pads.
- Add 5V output at the 10 MHz (instead of 3.3V one) – replace U18 with a 5V regulator.
- Limit the tuning range of the OCXO – replace RV1, R53, R52, R54 with other nominals.
- Replace the OCXO with another one which has Uref output – remove R53 and install R51, C75.
- Replace the OCXO with sinewave output (instead of square wave output) – remove R49 and install U15 (74HC4046) and neighbor components.
- Use OCXO with 12V power supply – cut the trace under JP2 and apply power to J11.

Test points:

- TP30 – check +5V here
- TP33, TP37 – 10 MHz output from the OCXO
- TP39, TP31, TP32, TP38 – check +3.3V
- TP36 – 10M_BUFFERED signal
- TP40 – 10 MHz from the output buffer
- TP34, TP35, TP41, TP42, TP43 – various test points related to frequency control of the OCXO

Jumpers:

- JP2 – cut the traces to disconnect the +5V regulator from the OCXO

Connectors:

- J15 – BNC 10 MHz output
- J11 – when JP2 is cut, apply external voltage to the OCXO via this connector
- J13 – when using external OCXO, inject 10 MHz into J13
- J14 – control voltage for an external OCXO
- J16 – output of buffered 10 MHz signal

Time Interval Counter

The TIC measure the time interval between the rising edges of the TIMEPULSE and 10M_BUFFERED signals. The U8 divider produces 100 kHz so the TIC is working properly if the OXCO frequency is a few PPM off the required value.

Modifications:

- Using 5 MHz, 25 MHz or other OCXOs – set up the U8 to produce 100 kHz from your OCXO, by replacing R79, R80, R78, R77, R39, R40.
- Manually reset the U8 – remove R75, R76 and wire TP19 and TP51 to unused pins of the MCU. Modification of the firmware is necessary.

Test points:

- TP26, TP27, TP28, TP29 – various frequencies produced by U8
- TP19, TP51 – manual reset of the U8
- TP8 – monitor the TIC_ENABLE signal

4x Clock Generator

The purpose of this module is to produce four arbitrary frequencies from the 10M_BUFFERED signal.

Modifications:

- Connect CLKx_P and CLKx_N signal for the in-phase output – short-circuit pins 1 and 2 of SB1…SB4. Changes in the firmware will be required.
- Use differential outputs – connect to pins 1 and 2 of SB1…SB4. Changes in the firmware will be required.

Test points:

- TP22, TP23, TP24 – use for experiments with different grades of the U6 chip
- TP21 – monitor the output of linear regulator
- TP25 – interrupt output of the U6

Connectors:

- J7…J10 – four BNC outputs
- SB1…SB4 – use for in-phase or differential output

MCU M0 Module

This module is an Arduino-compatible control unit for the Tokenblauser GPSDO.

Modifications:

- Install external crystal, Y2, as well as capacitors C24, C25.
- Install LEDs D4, D5 and resistors R5, R6 (470 R) to monitor TX and RX data at the virtual COM port.
- Install the RESET button (SW1)

Test points:

- TP3 – check the USB power (+5V)
- TP4 – MCU power (+3.3V)
- TP5 – AREF voltage of the MCU
- TP6, TP7, TP13, TP14, TP15, TP16 – unused MCU pins
- TP9, TP10, TP11, TP12 – I2C lines

Connectors:

- J4 – USB type B socket
- J5 – 10-pin SWD socket for bootloader programming, not installed
- J6 – 6-pin ICSP (legacy) socket, not installed
- P1…P16 – contact pins for connecting the Keyboard and Display board

Keyboard and Display

On this board, a 128x32 OLED and tactile switch buttons are installed. The 8 pads are soldered to P1…P16 on the both sides of the main board.