

10 GHZ TRANSVERTER

Ing. Petr KUTÍN, Doctoral Degree Programme (1)
Dept. of Radio Electronics, FEEC, BUT
E-mail: kutin@feec.vutbr.cz

Supervised by: Dr. Miroslav Kasal

ABSTRACT

In this paper, only the design of the transverter is described. A realization of the transverter isn't included. This transverter 10.368 GHz/144 MHz is designed on a single board with exception of the local oscillator (LO). A universal microwave chain that is a part of the transverter board multiplies the external 106.5 MHz LO. The TX (transceiver) mixer with a power amplifier (PA) and the RX (receiver) low noise amplifier (LNA) is not included. LNA is a part of the reflector feed by reason of the minimalization of a noise figure. The simulation program Serenade 8.5 was used for design of the transverter.

1 CONCEPTION OF THE TRANSVERTER

The goal of this project is a development of a simple single board 10 GHz transverter with an external 106.5 MHz oscillator. A low noise figure < 1 dB can be achieved for the RX and a clean 10 mW output power on 10.224 GHz for the TX mixer. The conception of the transverter is based on Kuhne [1], but there are many edits. The replacement of a cavity resonator by a microstrip filter is the most important change. The whole chain of LO and IF (intermediate frequency block) is shown in the block diagram of the transverter (fig. 1). LO conception is not included in this paper. The transmission and receiving path is composed of LO, the transverter, that is described here, of the TX mixer and PA and of a LNA, as a part of reflector feed.

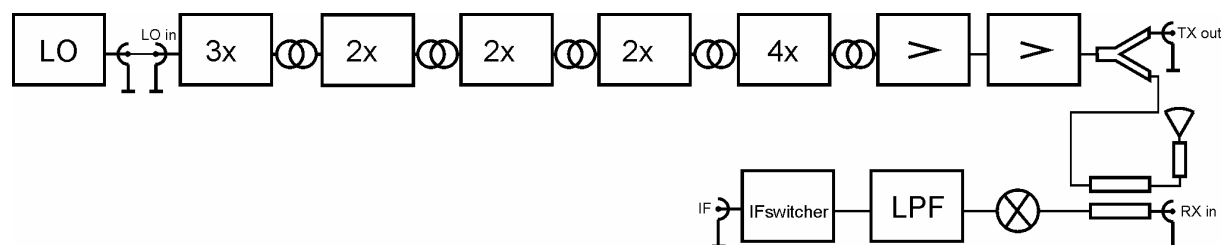


Fig. 1: Block diagram of the transverter

2 DESIGN

The external 106.5 MHz LO frequency is multiplied by a multiplier that uses two types of transistors. The first transistor is BFP540 by Infineon technologies. The second transistor is MGF1302. MGF1302 is a very popular in S, X and Ku band constructions. 24 GHz LO was developed using these parts [2]. Multiply sequence is following: 3×, 2×, 2×, 2×, and 4×. The most important change is in using a microstrip filter. The three types of microstrip filters are used. Description of each of them follows.

The interdigital microstrip band pass (BP) filter is based on blocked both ends earthed quarter-wave resonator principle. The resonator longitude is less than quarter-wave. Shortening was done by a capacitor at the end of the resonator. This solution is very advantageous, because the physical longitude of a filter is shortened, as well as there is possibility to tune the filter on the exact quarter wave of electric longitude. Trimmer condensers can do this. These trimmers should have good quality on the desired frequency range. This type of filter is used on frequencies roughly from 300 MHz up to 2 GHz.

Hairpin (BP) filter consist of coupled half-wave resonators that have hairpin shape by the reason of size reduction, whereby be short on halves. This type of filter is designed as a fast tuned. It can be disadvantage if the realization or design is imperfect (the filter can't be tuned to desired frequency as possible in an interdigital filter). The advantage of a precise designed fast tuned filter is a high long-term stability of the frequency.

The last type of a (BP) filter consists of half-wave resonator that is coupled by quarter-wave guides. The filter is usually used on relatively high frequency (roughly from 10 GHz). The filter size is too large on lower frequencies. This type of the filter is designed as a fast tuned. This filter has the same advantages and disadvantages as a hairpin filter [3].

The output power for the TX mixer should be greater then 10 dBm. A signal attenuation of a Wilkinson divider is 3 dB so requested parameters of LO, chain of multipliers and two stage amplifier are as follows:

Output frequency	10224 MHz
Output impedance	50 Ω
Output power	>13 dBm

A Wilkinson type hybrid divides the resultant LO - power on 10224MHz for the RX and TX mixers respectively. The RX mixer is a simple single balanced active mixer with GaAs - FET triodes and gate injection. As an active element the MGF1302 is used. The IF output is switched by a silicon diode (1N4148) switch from receive to transmit. A DC voltage present on the IF - line activates this. The voltages for the GaAs - FET's and bipolar transistors are generated in 7805 (voltage regulator) and ICL7660 (voltage converter) respectively. The schematic of the transverter is shown in fig. 2.

10GHz Transverter

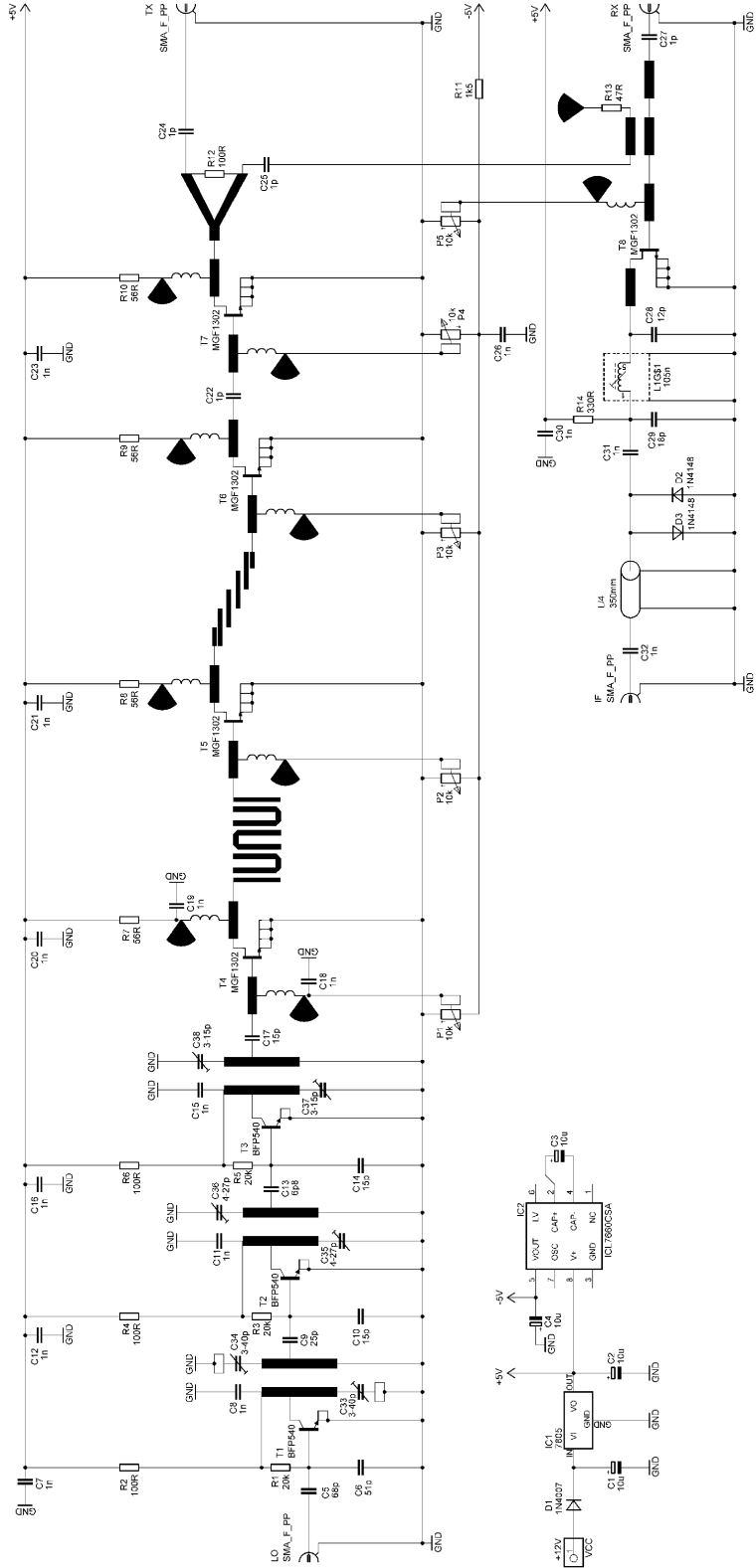


Fig. 2: Circuit of the transverter

3 SIMULATION OF THE RX MIXER IN SERENADE 8.5

The simulation program Serenade 8.5 was used for design of the transverter. The simulated RX mixer circuit is shown in fig. 3 as an example. There are three blocks, first for the definition of the substrate parameters, second for setup of working frequencies and the last block for nonlinear optimization.

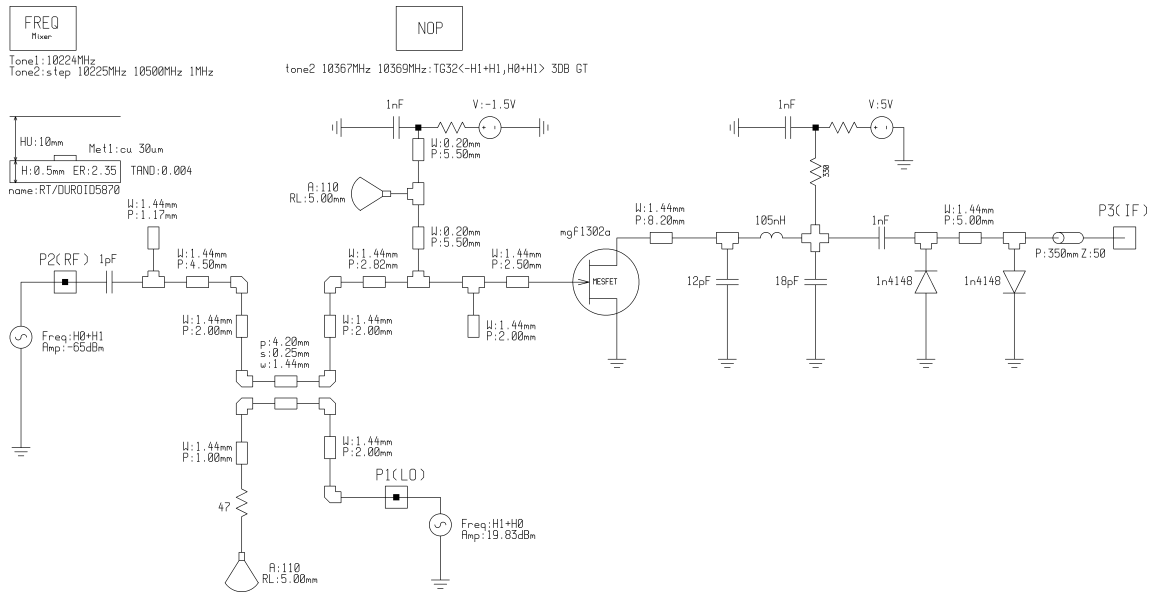


Fig. 3: Simulated circuit of the RX mixer in serenade8.5

The maximum of conversion gain for the RX mixer on 10.368 GHz is achieved by optimization of microstrip and lumped parts (fig. 4).

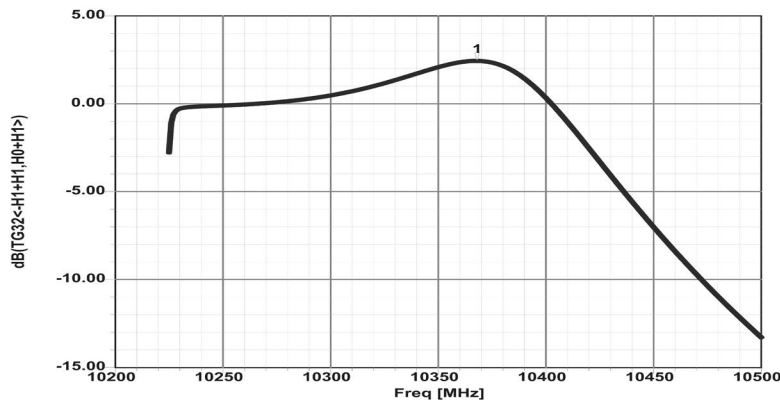


Fig. 4: Conversion gain of the RX mixer

4 CONSTRUCTION

Board with a printed circuit is soldered in a shielding box up on 10 mm. Power supply is injected by a capacitor bushing. The capacitor is also soldered to the box. Tetra screws fix SMA connectors. The transverter is made on a two-sided PCB. RT/duroid[®]5870 was chosen as a substrate. RT/duroid[®]5870 glass microfiber reinforced PTFE composite is designed for exacting stripline and microstrip circuit applications. Its low dissipation factor extends the usefulness of RT/duroid[®]5870 to X band and above. RT/duroid[®]5870 laminate is easily cut, sheared and machined to shape. It has excellent dimensional stability and is resistant to all solvents and reagents hot or cold, normally used in etching printed circuits or in plating edges and holes. There is a motive of a printed circuit in fig. 5. Actual dimensions of the board are 181.2 × 61.8 mm.

5 CONCLUSION

Measured results are not available because only the design of the transverter was done. Reliability of the local oscillator was attested in [2]. The same procedure of a multiplication (with the same types of the filters) was used in this transverter. Usage of these filters in the transverter is very modern solution because microstrip filters are more and more popular at the designing of microwave constructions.

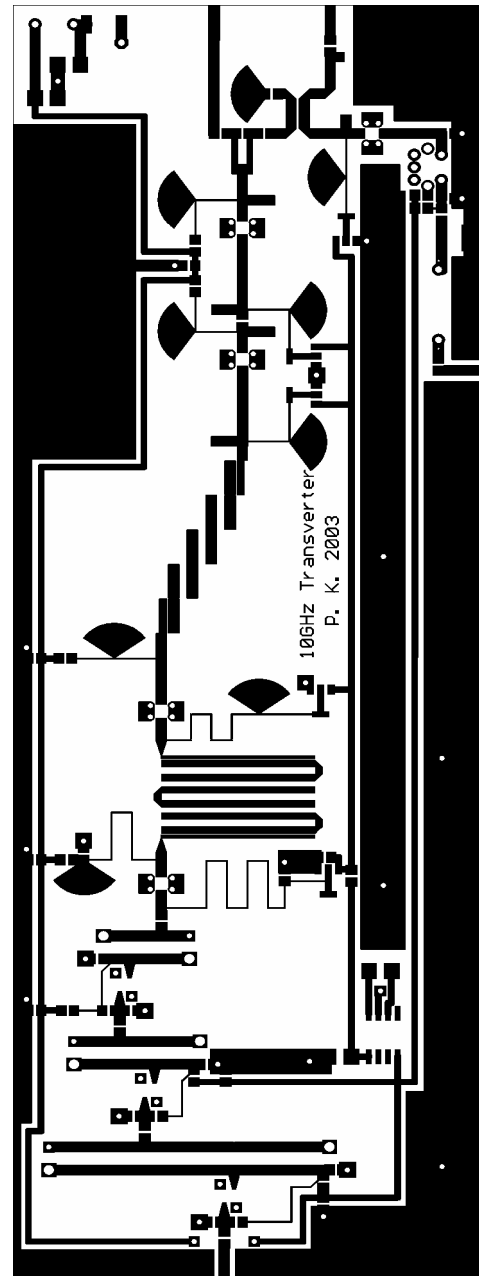


Fig. 5: *Layout of the transverter*

REFERENCES

- [1] Kuhne, M. – Dahms, J.: A Simple 10GHz Transverter, <http://www.mrs.bt.co.uk/dubus/9101-1.pdf>
- [2] Kutín, P.: Local Oscillator for Converter in 24 GHz Band, [Diploma Thesis], FEEC BUT, 2002
- [3] Kutín, P.: Design and Application of Microstrip Filters in High-Frequency and Microwave Technique, *Elektrorevue – Internet Journal* (<http://www.elektrorevue.cz>), ISSN 1213-1539, 2002, vol. 2002, No. 58