Active Splitter

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Abstract - **A four-pole VHF and UHF band active splitter is described below. Its transmission gain is almost one. The broadband matching of the splitter is made by an imitation of transmission line whit impedance 75 Ω. The input capacitance of the MOS transistors is used. All the values of the band are calculated. An electrical circuit scheme and measurement results are given.**

Keywords - **Active splitter, broadband matching, active circuit element, active element, cut-off frequency, VHF and UHF band, return loss, WSVR, LC filter, MOS-transistors.**

I. INTRODUCTION

As the cable television is coming into its own and in connection with building of closed TV nets it is necessary to connect more than one TV set to the signal source. The most widely distributed splitters are the passive ones. These passive devices represent two or more pole broadband transformers. There also are splitters that use resistive division with good matching but they bring some losses. Depending on the scheme a four pole resistive divider brings fading between 8 and 12 dB.

II. SYNTHESIS IMPLEMENTATION

The given scheme is a four pole active splitter. Every pole has transmission loss near one. A broadband matching method is applied. A low pass LC filter is used. Its characteristic impedance is 75 Ω and it is shown on Fig 1.

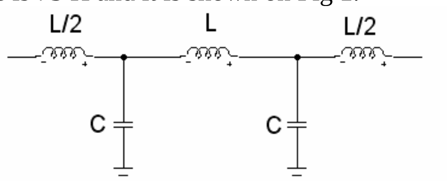

Fig. 1

Instead of the capacitors C the internal capacitances of the four MOS transistors are connected (two transistor BF998 are connected in parallel). Using [4] their internal capacitance is 2,1pF. The inductance and the cut-off frequency f_c of this filter is calculated using [2]:

$$L = z_0^2 C = 75^2.2.2,1.10^{-12} = 23,625.10^{-9}\left[\mathrm{H}\right], \quad (1)$$

$$f_c = \frac{1}{\pi\sqrt{LC}} = \frac{1}{\pi\sqrt{23,625.10^{-9}.4,2.10^{-12}}} = 1010,6.10^6 \cdot \quad (2)$$

Obviously the pass band is long enough to cover the TV envelopment. The scheme is given on Fig. 2

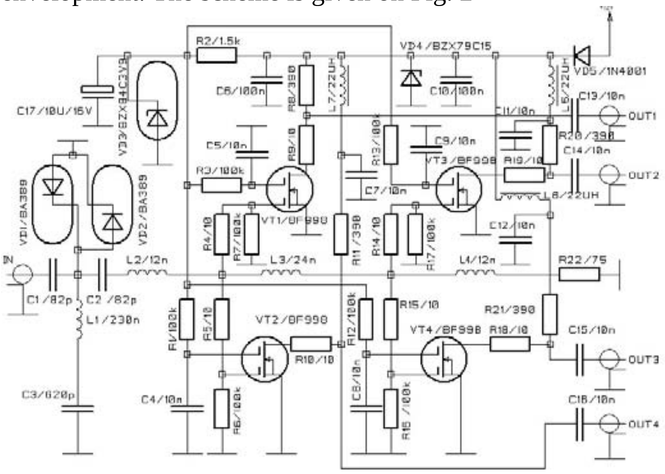

Fig. 2

In the lead-in an inverse Hausdorff high-pass filter with 75Ω impedance is connected. Its cut-off frequency is 30 MHz. It has maximal-flat characteristics in the pass band and a minimum attenuation in stop band 27[dB]. The inverse Hausdorff filters have better linearity of the phase-frequency response in comparison with the elliptic and inverse Chebyshev's filters [3]. The PIN diodes VD1 and VD2 protect the splitter from atmospheric over voltage. The transistors VT1÷VT4 are aperiodic broadband amplifiers with gain about one. The zener diode VD3 ensure fore voltage 3,9V supplied to the second gates of the transistors. The resistors connected in series with the first gates and drains of the transistors protect the amplifiers against self-oscilation.

Having in mind the newly introduced elements, the equivalent scheme of the filter is shown on Fig. 3.

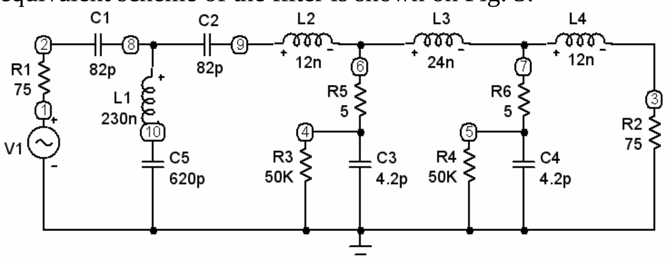

Fig. 3

The inductances L_1, L_2, L_3 and L_4 are calculated using [1]. For $\frac{D}{b} \le 1$:

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$$L = \frac{\pi^2 D^2 w^2}{b}\left[1 - \frac{4}{3\pi}\left(\frac{D}{b}\right)^2 + \frac{1}{8}\left(\frac{D}{b}\right)^2 - \frac{1}{64}\left(\frac{D}{b}\right)^4\right].10^{-7}. \quad (3)$$

For $\frac{D}{b} > 1$:

$$L = \pi D w^2 \left\{ 2\left[1 + \frac{1}{8}\left(\frac{b}{D}\right)^2 - \frac{1}{64}\left(\frac{b}{D}\right)^4\right]\ln\left(\frac{4D}{b}\right) - \left[1 - \frac{1}{64}\left(\frac{b}{D}\right)^2 - \frac{1}{48}\left(\frac{b}{D}\right)^4\right]\right\}.10^{-7}, \quad (4)$$

where D is the average diameter of the coil, b is the length and w is the number of the windings. If the diameter of the isolated wire is 0,35mm the next values are calculated:

L_1 – ten dense windings over solid body with diameter 3mm – inductance 225,5 nH.

L_2, L_4 – two dense windings over solid body with diameter 2mm – inductance 12,57 nH.

L_3 – three dense windings over solid body with diameter 2mm – inductance 23,28 nH.

Fig. 4 shows a computer simulation of magnitude response in node 3 of the equivalent scheme on Fig. 3. There you can see that the frequency band of the active splitter is 30MHz÷809MHz.

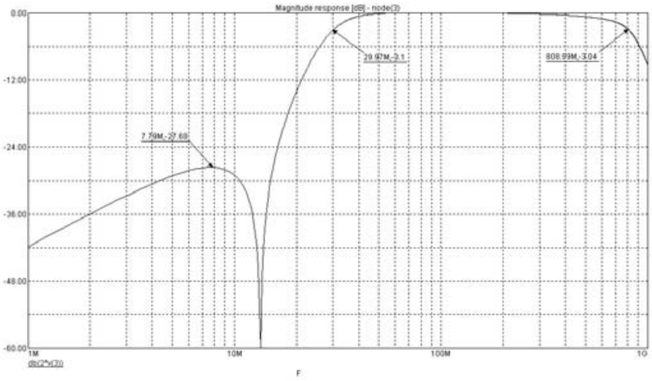

Fig. 4

Fig. 5 shows a computer simulation of magnitude response in node 4 of the equivalent scheme on Fig. 3.

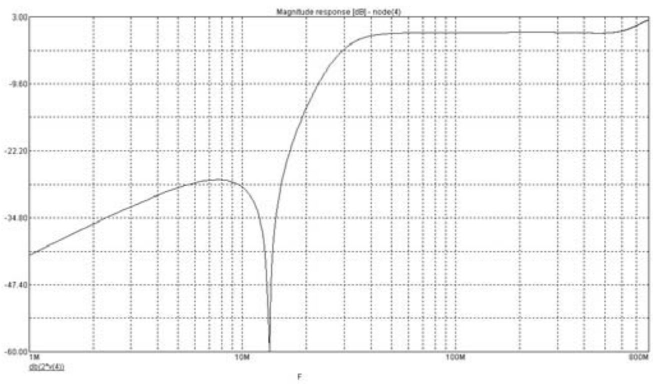

Fig. 5

On Fig. 6 is shown the measured magnitude response of the active splitter on output 1 (OUT1) in its practical realization.

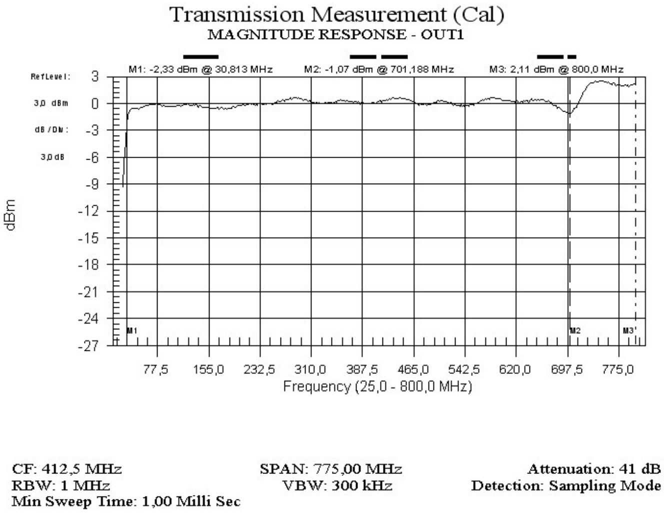

Fig. 6

Fig. 7 shows a computer simulation of magnitude response in node 5 of the equivalent scheme.

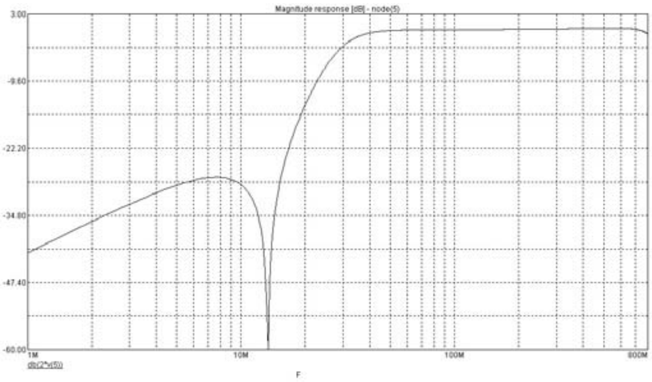

Fig. 7

On Fig. 8 is shown the measured magnitude response of the active splitter on output 2 (OUT2) in its practical realization.

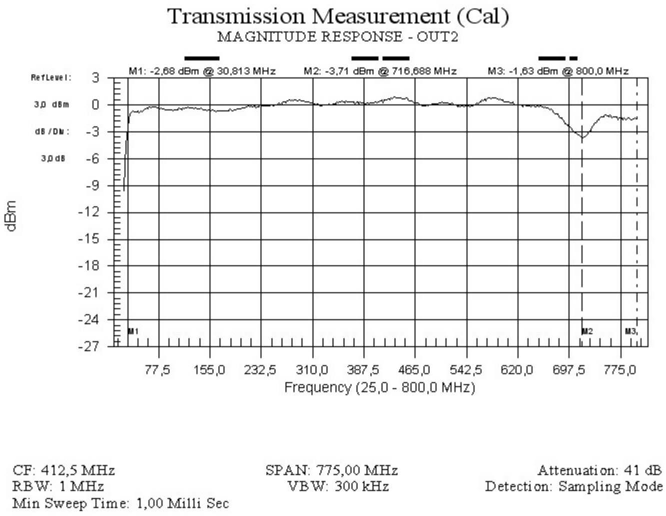

Fig. 8

On Fig. 9 is shown the measured input return loss a in [dB].

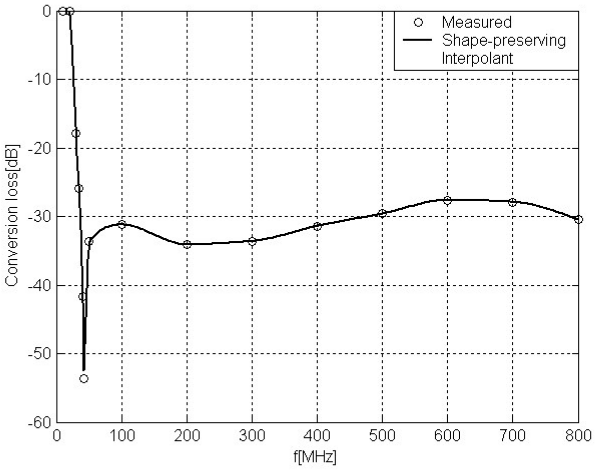

Fig. 9

WSVR is calculated from [2]:

$$|r| = 10^{-0,05a};\qquad (5)$$

$$\text{WSVR} = \frac{1+|r|}{1-|r|}.\qquad (6)$$

On Fig. 10 is shown the active splitter's input WSVR.

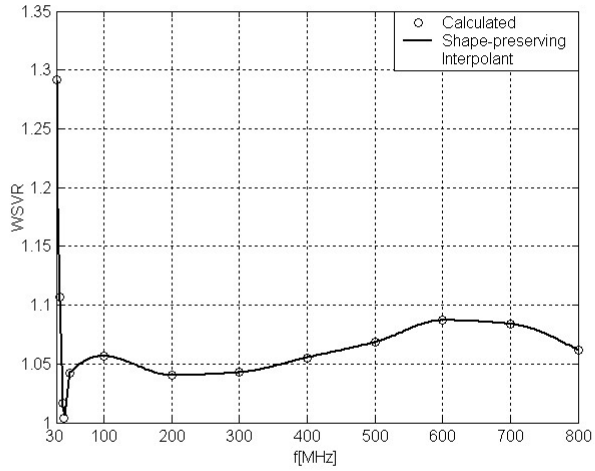

Fig. 10

The values of WSVR are less than 1,3, where in band 36-800MHz they are less than 1,09.

The consumption of the active splitter is about 55 mA (12V-DC), the signal isolation between two arbitrary outputs is more than 36dB.

III. Conclusion

– An electrical scheme is built of an active splitter using MOS transistors.

– Through the realization of the electrical scheme the formulas (1), (2), (3) and (4) give the necessary accuracy.

– The illustrated computer simulation of the electrical scheme in the examination frequency band covers the measured parameters of the practical realization.

– The MOS transistor active splitter is realized and successfully realized in many objects in Republic of Bulgaria.

References

[1] Savov, G., Constructing and technology of the radio electronic apparatuses –Sofia, Technica, 1970

[2] Lendi, R., D. Davis, A. Albrecht – Radio engineer's guide – Moscow – Electrical Publishing House 1967

[3] Apostolov P. S. "Hausdorff LC Filters", - *ICEST 2004 Conference Proceedings*, pp.59-62, Bitola, Macedonia, 2004.

[4] Philips Semiconductor Concise Catalogue 1995, pp. 4-53