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Pre Divider (:10) up to 5GHz

A frequency counter is part of the standard equipment in almost any radio-frequency laboratory, but the frequency range usually goes up to no further than 1.3GHz. Although almost all measurements are carried out within this range, we nevertheless often wish we could measure higher frequencies as well. As an alternative to purchasing an expensive microwave counter, there is the option of expanding the range of an existing piece of apparatus with an external pre-divider.

1. Circuit description

There are only a few components in the circuit of the pre-divider for frequency counters, Fig. 1 shows the wiring diagram. A similar pre-divider was presented a few years ago in [1]. Since the Plessey SP 8910 divider IC used has not been obtainable for some time, the project has tended to be forgotten. In the meantime, this IC has been brought back, and is currently available (once again) in a modern SMD housing from Zarlink [2]. So what could be more obvious than to develop a new frequency divider using this IC?

At the pre-selector input of the circuit there is a very broad band ERA-1 amplifier from Mini Circuits [3]. It amplifies the input signal up to 5GHz with approximately 11 to 12dB, before the signal is fed to the actual divider, U2, at PIN 2.

Like other dividers, this one also oscillates without an input signal, in which case approximately 550MHz can be measured at the output. On some dividers, this oscillation can be suppressed by means of a resistance between the input pin and earth, but this was not successful here.

The resistor R3 provides for an output impedance of approximately 50 Ohms, and the output level is approximately -10dBm. But the required input level represents a greater problem. The curve in Fig. 2 shows how high the minimum level must be for the divider to function satisfactorily. We can also see that the divider can still be used over 5GHz. Be careful the input levels are not too low! Fig. 3 shows what happens at the output, with an input frequency of 1GHz, if the input level (27dBm) is too low, an input frequency of 2GHz is faked! Figs. 4 and 5 in contrast show the spectrum at the output with the correct input levels. Input levels that are too high should likewise be avoided.

The supply voltage for the divider is stabilised with a fixed voltage regulator (U3). The one selected here was in a TO-220 housing.

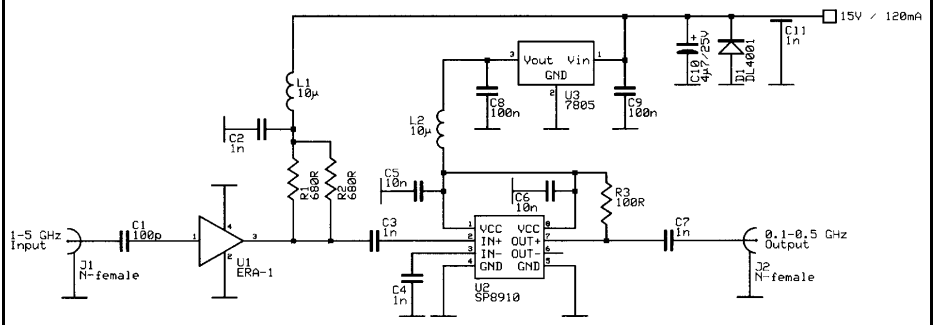

Fig 1: Circuit diagram of 5GHz pre divider.

2. Circuit assembly

The circuit is assembled on a 45mm x 30mm Teflon printed circuit board (Fig. 6). This has a gap at one corner for the voltage regulator, U3.

When building the printed circuit board in accordance with the component layout (Fig. 7), pay particular attention to mounting the amplifier U1. Its earth connections must be connected to the earth side of the printed circuit board by the shortest path, or it will have a tendency to oscillate due to the feed inductances arising.

Earth connections using through plating are not successful unless there is sufficient through connection. So another method is used here, which is always successful. The MMIC is sunk into a hole (∅ 2.3mm) in the board itself. The earth connections are bent downwards and soldered flush with the earth surface.

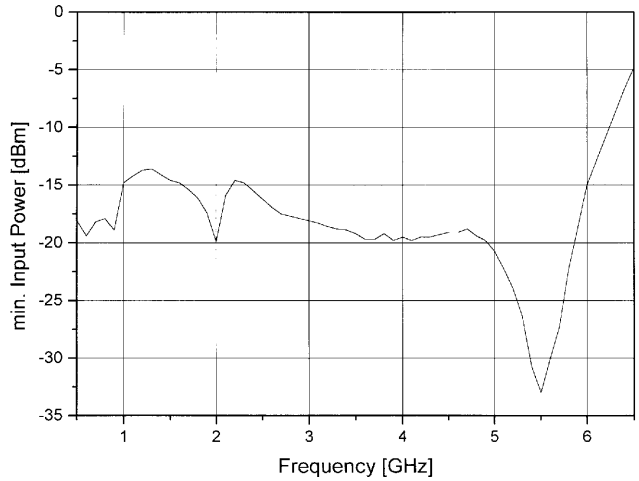

Fig 2: Minimum input level for divider to function correctly.

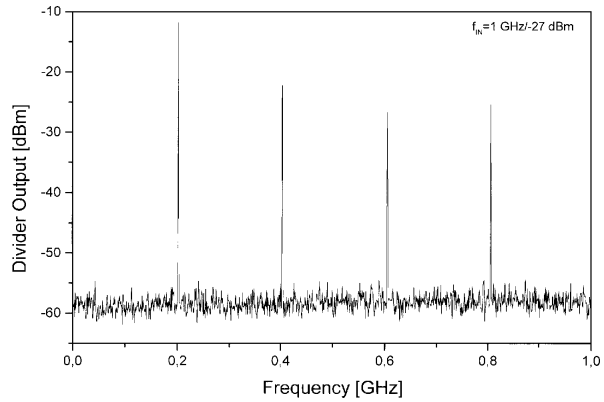

Fig 3: Output of divider when input level is too low (1GHz, -27dBm).

In the same way, the inputs and outputs are bent upwards and soldered to the tracks.

When the board has been fully populated (except for the voltage regulator), the flux residues are cleaned off the earth side and it is screwed into the milled aluminium housing. Then the voltage regulator and the connectors can also be fixed and soldered on.

Before the housing is screwed down, the top of the board should be cleaned again and the circuit should be tested. You should also make sure that U1 is not oscillating!

2.1. Parts list

U1	ERA-1 (Mini-Circuits)
U2	SP8910 (SO8, Zarlink)
U3	7805
C1	100pF, 0805
C2,C3,C4,C7	1nF, 0805
C5,C6	10nF, 0805
C8,C9	100nF, 0805
C10	4.7µF/25 V, SMD
C11	1nF DF capacitor, M3 Actipass AFC-102P-10A
L1,L2	10µH, SMD

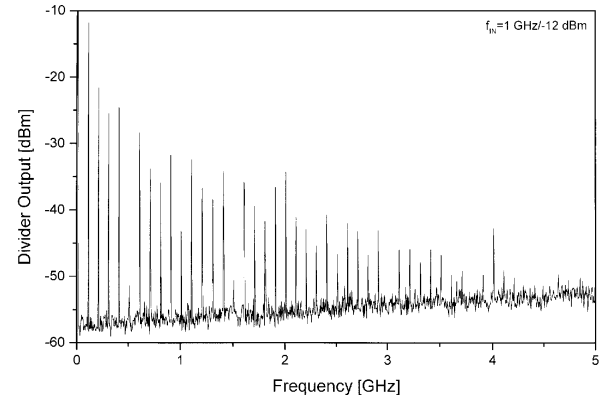

Fig 4: Output of divider when input level is correct (1GHz, -12dBm).

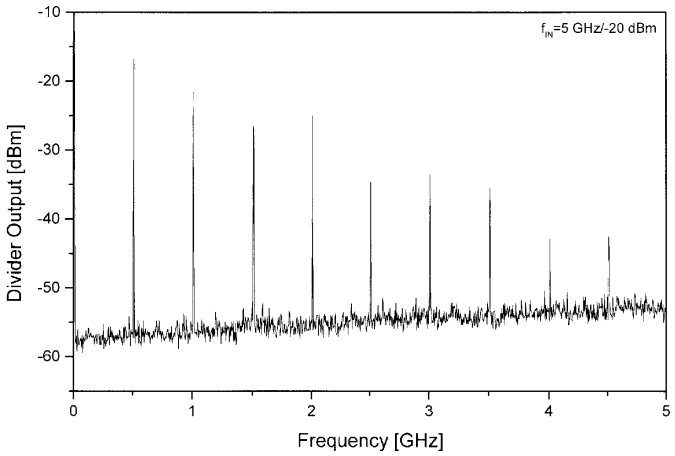

Fig 5: Output of divider when input level is correct (5GHz, -20dBm).

R1,R2	680R, 1206
R3	100R, 1206
2 x	N-flanged sockets, small 4-hole flange
1 x	Teflon PCB, DG6RBP 002, through plated
1 x	Aluminium housing
1 x	Soldering lug 3.2 mm for C11 (earth connection)

3. Technical data

Input freq. range	1 to 5 GHz
Output range	100 to 500 MHz
Divider factor	10
Input level approx.	13 to 7 dBm
Output level approx.	10 dBm
Input/output	N socket
Supply	+15 V, 120 mA

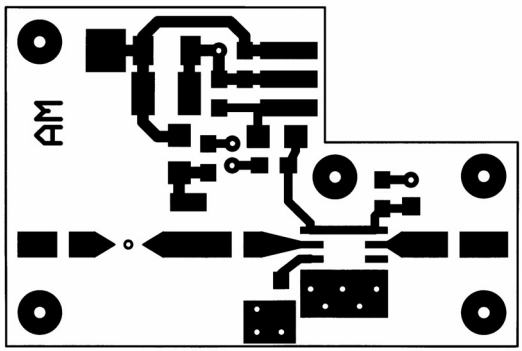

Fig 6: Printed circuit board layout for 5GHz pre divider.

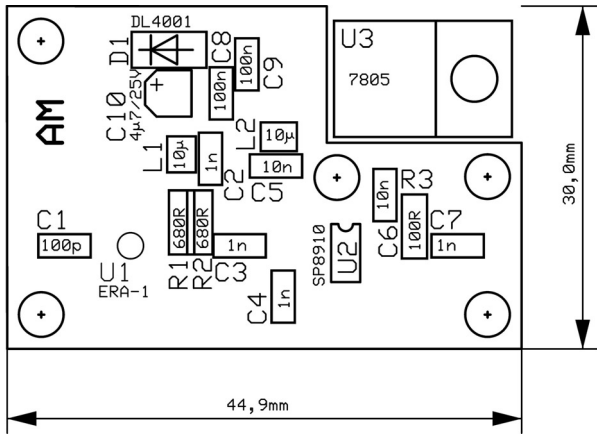

Fig 7: Component layout for 5GHz pre divider.

4. Literature

[1] Dr.-Ing. J. Jirmann und Michael Kuhne: Measurement aids for the UHF amateur, VHF Reports 1/93, Verlag UK-W-Berichte, Baiersdorf and VHF Communications 4/1993 Pp 207 - 213

[2] Data sheet SP8910, Zarlink, www.zarlink.com

[3] Data sheet ERA-1, Mini-Circuits, ww.mini-circuits.com

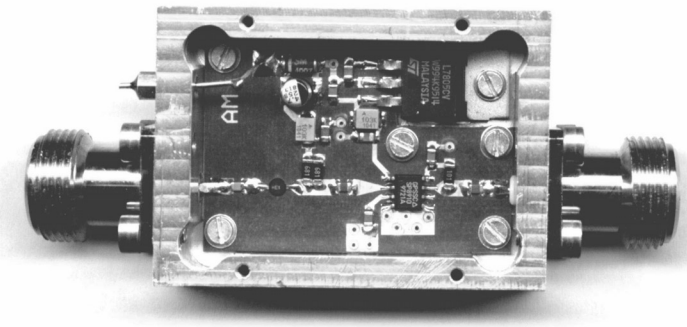

Fig 8: Photograph of completed 5GHz pre divider.