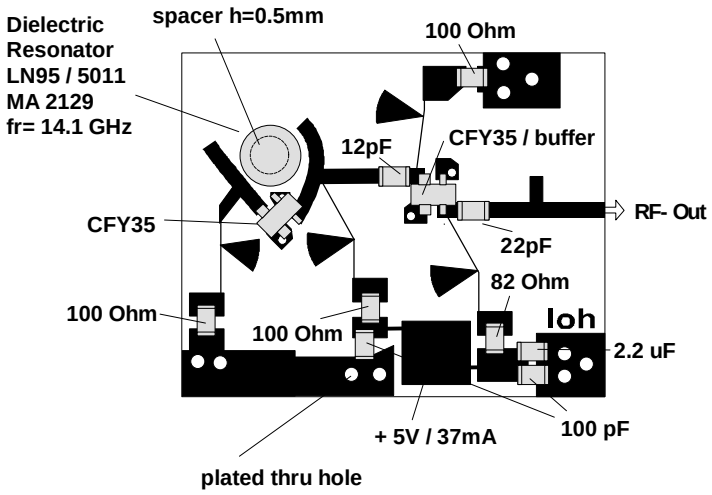
G. Lohninger

A 15 GHz GaAs-FET Buffered Oscillator

A buffered stable oscillator has been developed using a parallel feedback circuit, two CFY35 GaAs- field effect transistors and a dielectric resonator. In addition a spacer for a high resonator quality-factor is added. The design goals for this oscillator are high output power > 10 dBm, low phase noise < -95 dBc/Hz at 100 kHz offset and high stability versus load impedance variations and versus temperature. The emphasis has been also on small size and high reliability (Fig.1/ 2).



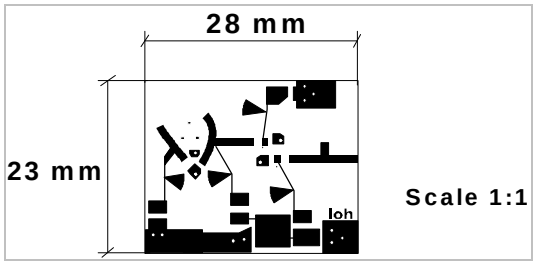
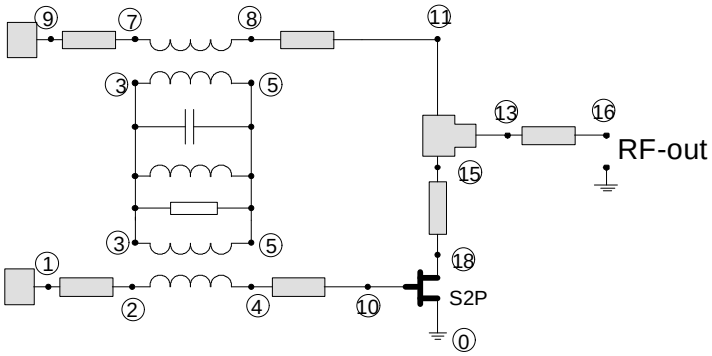


Fig. 1 / 2 The buffered oscillator circuit on a teflon board (er= 2.4, h= 0.38mm and t=17,5 µm Cu) consists of several surface mounted devices and plated thru holes. The resistors and capacitors used have dimensions of 2mm x 1.27mm. The CFY35 transistors are housed in a MW4 package.

By turning on the DC-bias, the oscillator starts up from noise to a power level, that depends on the load impedance i.e. the input reflection coefficient of the buffer amplifier circuit. That is why the capacitance 12 pF can be used to optimize the tuning range and the output power of the parallel feedback oscillator circuit.
A microstrip tuning stub and the capacitor 22pF at the output of the buffer amplifier provide high gain values.

Table 1 and Figure 3 / 4 show the small signal simulation of the oscillator. The output MAG S11 can be maximized up to 40 by the variation of the microstrip lines. Though Microwave Harmonica 6.0 offers a DR-model, a RLC-circuit and two ideal transformer (trf) simplify the simulation.

```
BLK
 trl 1 2 w=1.1mm P=5.12mm    sub
 open 1 w=1.1mm sub
 trf 2 3 4 5 n=1
 cap 3 5 c=81.4pf
 ind 3 5 l=1.375pH
 res 3 5 r=165
 trf 3 7 5 8 n=-1
 trl 7 9 w=1.1mm p=2.5mm     sub
 open 9 w=1.1mm              sub
 trl 4 10 w=1.1mm p=2mm      sub
 trl 8 11 p=1mm     sub      w=1.1mm
 tee 11 15 13 w1=1.1mm w2=1.1mm w3=1.1mm sub
 trl 15 18 w=1.1mm p=3mm     sub
 two 10 18 0 b2
 trl 13 16 w=1.1mm p=3mm     sub
dro:1por 16
END
FREQ
 step 14.95ghz 15.05ghz 2mhz
END
OUT
 pri dro sk
END
DATA
 sub:ms er=2.4 h=0.380mm met1=cu 0.125mil
 tand=0.0001
 b2:d1 file=c:\6compact\loh\10901n1.s2p
END
```



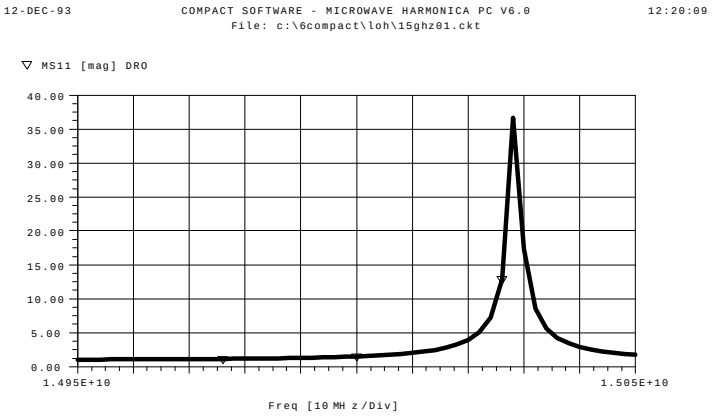


Table 1 and Fig. 3 / 4 Small signal analysis of the oscillator without buffer amplifier.

The two circuits - oscillator and buffer amplifier - are working in a saturation current mode. The operating current without oscillation (I_{DSS}, U_G=0) will be reduced by self biasing effects after start up.

Table 2 shows the typical characteristics of the circuit housed in a metal cavity. Please pay attention to cavity oscillation effects. These phenomenas can be avoided by the use of absorber material or optimized cavity dimensions.

Operating frequency	14.5 to 15.3 GHz
Operating temperature range	- 40 °C to + 120 °C
Ouput power	12 dBm
Power variation with temperature (-40 °C to + 120°C)	± 1 dB
Load impedance	50 Ohms
Frequency stability versus temp. (-40 °C to + 120°C)	- 2MHz to + 7MHz
Frequency pushing versus bias voltage	3 MHz / V
Phase Noise at 100 kHz offset	< - 95 dBc/Hz
Bias voltage	+ 5 V
Bias current	37 mA

Table 2 Typical characteristics of the buffered oscillator.

References

1) R. Soares: GaAs-MesFET Circuit Design, Artech House, Inc., 1988.
2) G.Gonzales: Microwave Transistor amplifiers - Analysis and Design, Prentice-Hall, Inc., 1984.
3) Application Note No.002: Silicon Bipolar-Dielectric Resonator Oscillator (DRO) at 10 GHz
4) G. Lohninger, "Oszillatordesign in der Hochfrequenztechnik," Elektronik, Heft 03/95.

G.Lohninger HL EH PD1 3.1.95

Published by Siemens AG, Bereich Bauelemente, Vertrieb, Produkt-Information, Balanstraße 73, D-81541 München