GaAsFET PREAMPS FOR 902 MHz. AND 1296 MHz.

AS-49-36

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1296 MHz MICROSTRIP PREAMPLIFIER

This preamplifier, like the other two in this note, was designed for a narrow band application. The preamplifier does have reasonable gain outside of the amateur 1296 MHz band, but this was not the intent of the design. Only the S11 and S22 parameters were used in the design. The S12 and S21 parameters were ignored. S11 and S22, the input and output reflection coefficients respectively, were plotted on a Smith Chart. From the Smith Chart plot it was apparent that just a little inductance in the gate circuit would match things nicely. The first try yielded a rather easy input microstrip design, but would not provide a means to optimize the match for best noise figure. Therefore, it was decided to use a small high Q coil which could be changed, squeezed or stretched for best noise figure. The first printed circuit board had a pad on the board for the junction of the coil and GaAsFET gate lead. Later tests showed that this pad degraded the noise figure by 0.2 dB. The most recent design has the gate lead and coil lead floating in midair. Obviously this is not a near arrangement, but in the trade off between noise figure and neatness, the floating junction won out.

The drain circuit is a simple stub matching technique one would use in matching a 50 ohm transmission line to a reactive load. The GaAsFET is the reactive load. A standard 50 ohm microstrip line was used to do the matching. A 51 ohm resistor in series with a quarter wave length of microstrip line is in shunt with the 50 ohm output lead. At low frequencies the 51 ohm resistor keeps the drain circuit terminated. At 1296 MHz the quarter wave stub is resonant and therefore presents a high impedance. Consequently, the 51 ohm resistor is decoupled from the drain circuit. Hopefully this stub circuit adds to the low frequency stability of the preamplifier.

Several preamplifiers were built with this circuit,and several different devices were used. The DXL2501, DXL2503, MGF1400, VSF9332, and D432 were tried. All yielded very good results. Noise figures fell between 0.4 and 0.6 dB. The gain measured between 15 dB and 19.5 dB. The MGF1400 shown in the picture measured 0.5 dB at a gain of 19.5 dB. The gain peaked at 1280 MHz and was 20.5 dB. The gain peak could be moved to 1296 MHz by adjusting the gate coil, but the noise figure degraded. The input return loss was 12 dB, and the output return loss measured at 25 dB in the unit pictured. The MGF1200 was not tried, but it should perform in an acceptable manner in this circuit.

Figure 1

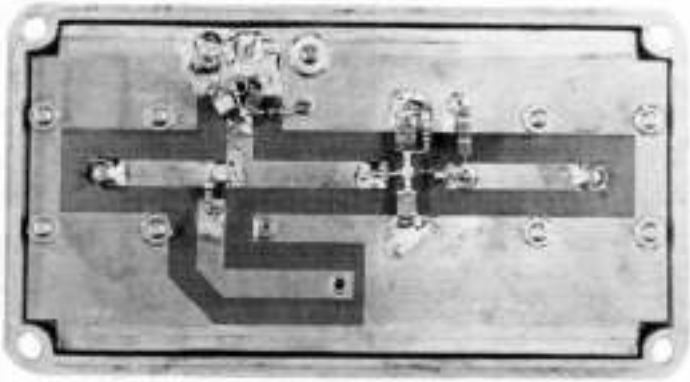


Figure 2

These pictures of the 1296 MHz microstrip preamplifier may be used with the 902 MHz preamplifier as well.

Figure 3

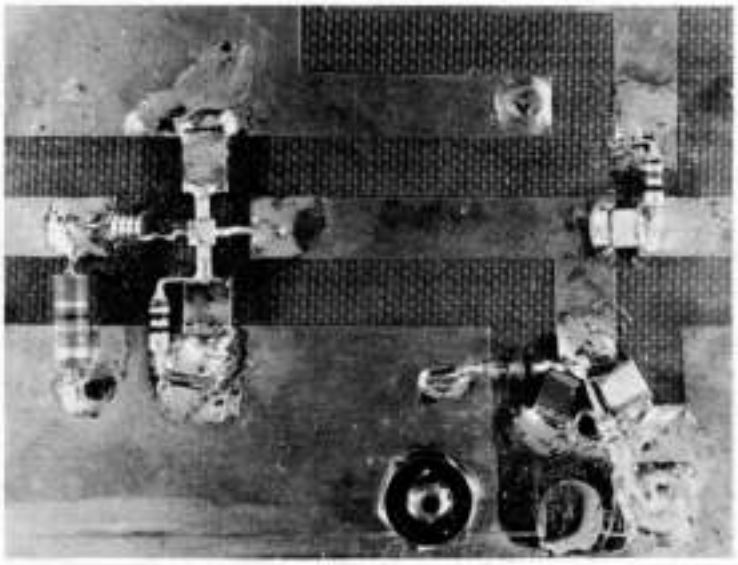
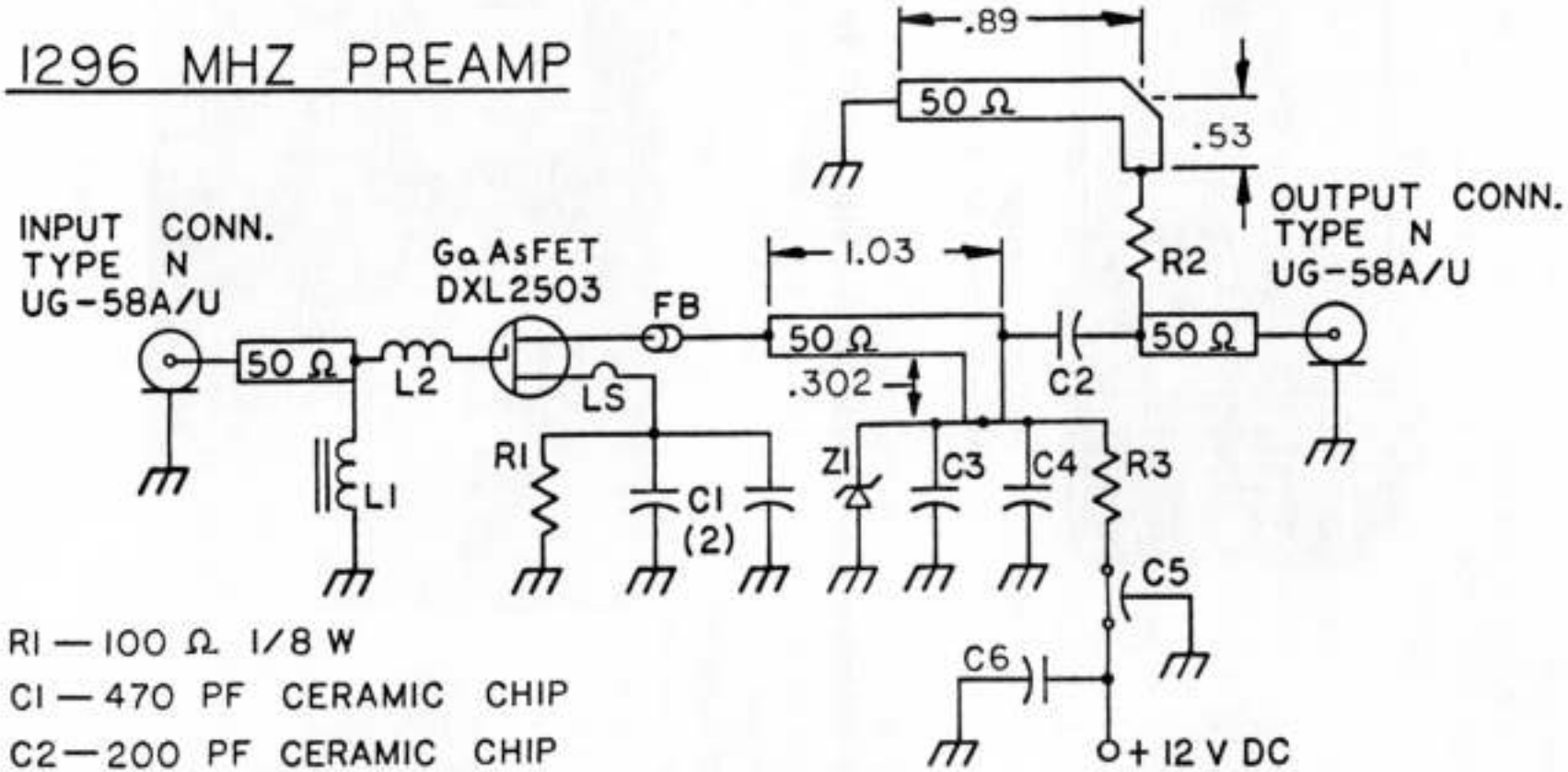


Figure 4

1296 MHZ PREAMP



R1 — 100 Ω 1/8 W

C1 — 470 PF CERAMIC CHIP

C2 — 200 PF CERAMIC CHIP

C3 — .01 MF CERAMIC CHIP

C4 — 10 PF CERAMIC CHIP

C5 — 1000 PF FEEDTHRU

C6 — 0.1 MFD CERAMIC

Z1 — IN748 ZENER DIODE

L1 — RF CHOKE 0.82 μH
MICROMINIATURE
J.W. MILLER # 9230-18

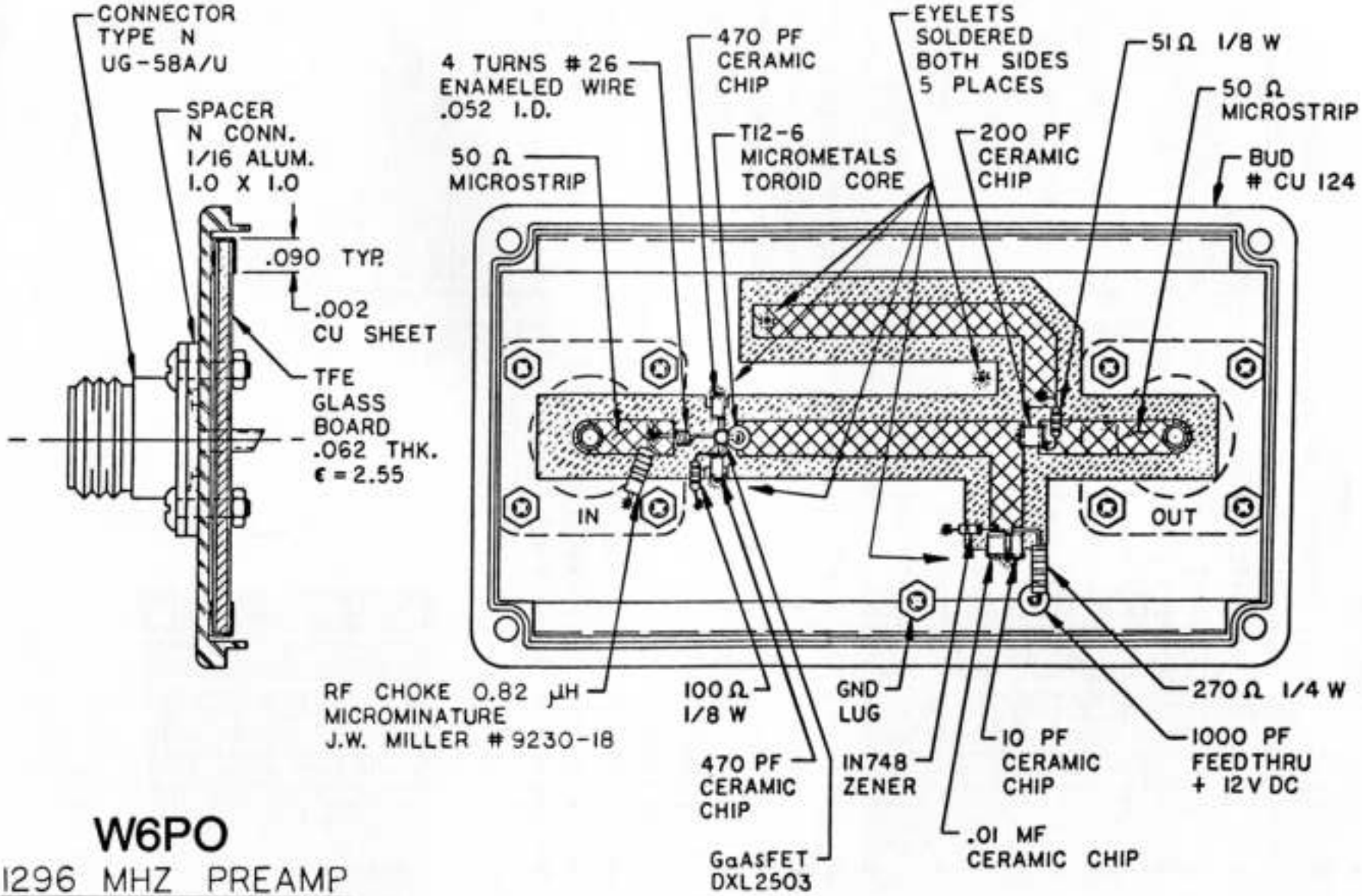
R2 — 51 Ω 1/8 W

L2 — 4 TURNS CLOSE WOUND
#26 ENAMELED WIRE
.052 I.D.

LS — INDUCTANCE OF SOURCE
LEADS ON GaAsFET

FB — T12-6 MICROMETALS
TOROID CORE

R3 — 270 Ω 1/4 W



W6PO

1296 MHZ PREAMP

1296 MHz UG141/U PREAMPLIFIER

Using the same design approach as in the microstrip unit, a preamplifer was built inside a small Pomona 2417 box. The object of this effort was to design a relatively inexpensive and easily-built preamplifier with acceptable performance. Johanson type tuning capacitors were ruled out as being too expensive. Microstrip was also ruled out because not all amateurs feel at home making such a board, even though the board can be easily etched or cut out with an Exacto knife. Most amateurs can promote some pieces of UG141/U rigid coax. The drain matching circuit was accomplished in the same manner as with the microstrip, except now the transmission line used is made of UG141/ coax.

The preamplifier shown in the pictures uses a DXL3501 GaAsFET. This is a power FET not normally used as a receiving preamplifier. The S22 for this FET is much smaller in amplitude due to the higher drain current for the same drain voltage. By changing the lengths of the drain matching circuit the D321, MGF1400 and MGF1200 can be used. For these other GaAsFETs the length of the UG141/U between the device and the 200 pfd coupling capacitor should be 1.11 inches long and the stub from the capacitor to ground should be 0.324 inches long. The gate coil should start out as four turns of #26 wire 0.052 inches in diameter (#55 drill); then adjust the coil for best noise figure. Be certain there is enough selectivity in your measuring system so as to not count the image frequency. This is especially important for a 28 MHz intermediate frequency. Use a quarter wave resonant cavity filter after the pre-amplifier to be sure. The preamplifier does not have enough selectivity by itself.

This preamplifier measured 0.4 dB on the noise figure meter and had a gain of 15 dB.

Figure 5

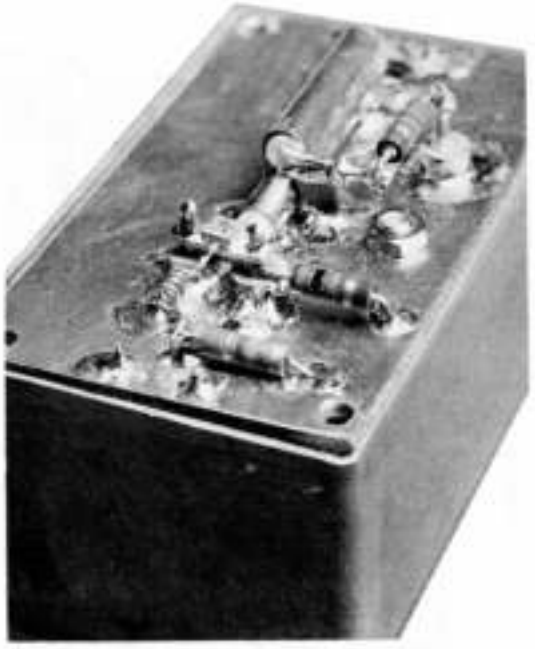


Figure 6

These pictures are of the 1296 MHz preamplifier using UG-141/U rigid coax and mounted in a Pomona 2417 box.

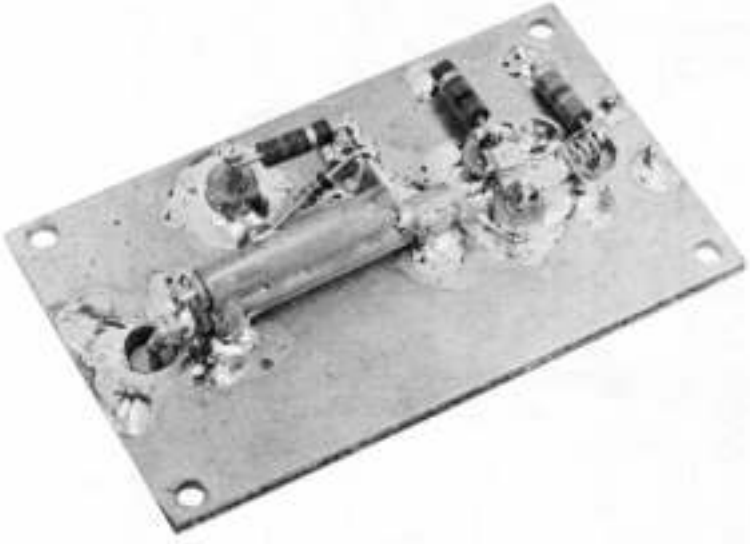


Figure 7

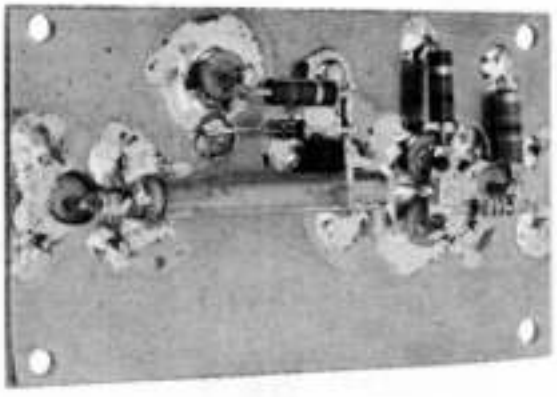
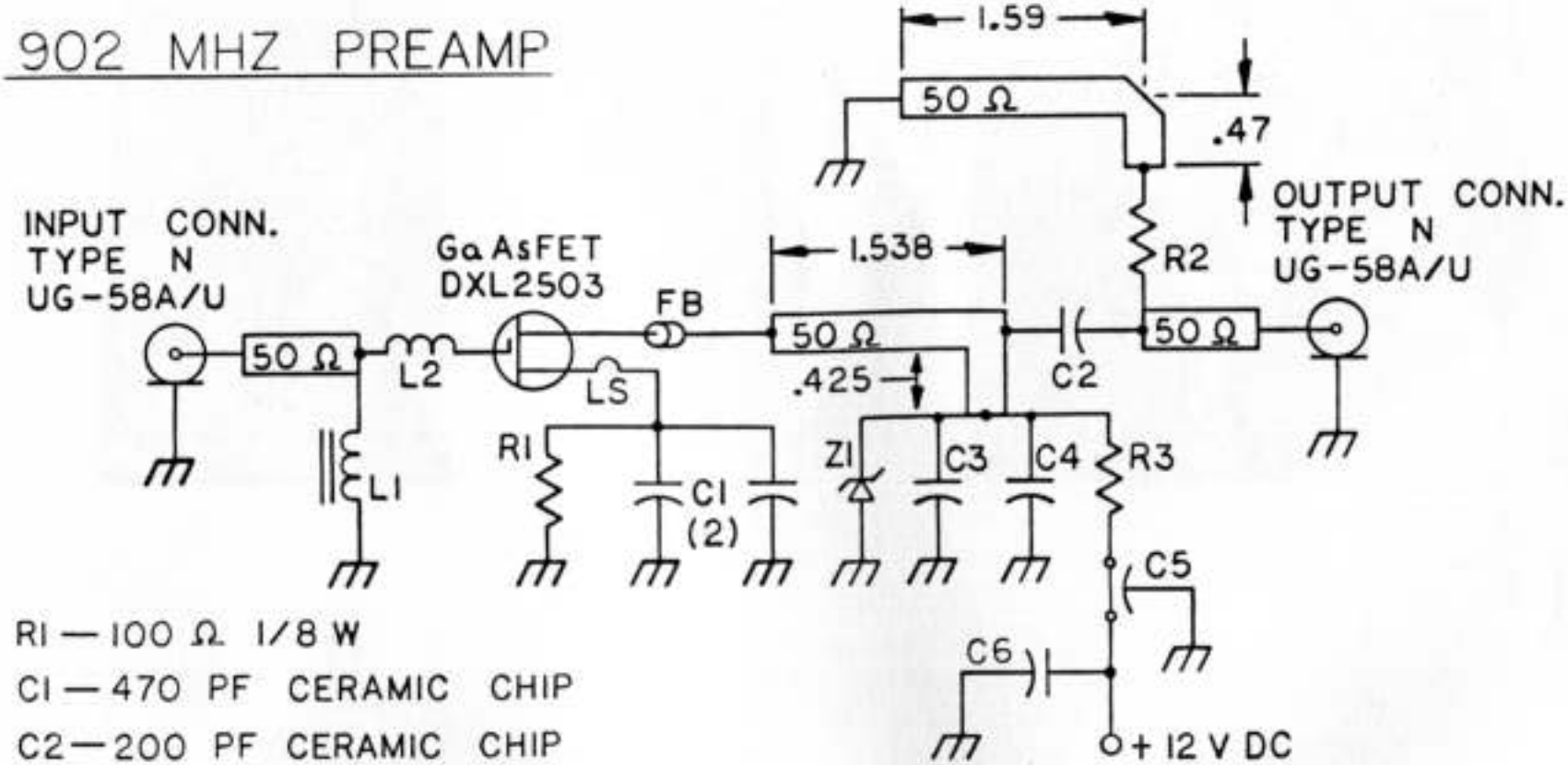


Figure 8

902 MHZ PREAMP



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C1 — 470 PF CERAMIC CHIP

C2 — 200 PF CERAMIC CHIP

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C4 — 10 PF CERAMIC CHIP

C5 — 1000 PF FEEDTHRU

C6 — 0.1 MFD CERAMIC

Z1 — IN748 ZENER DIODE

L1 — RFC-4B FERROXCUBE
#30 ENAMELED WIRE
8 TURNS

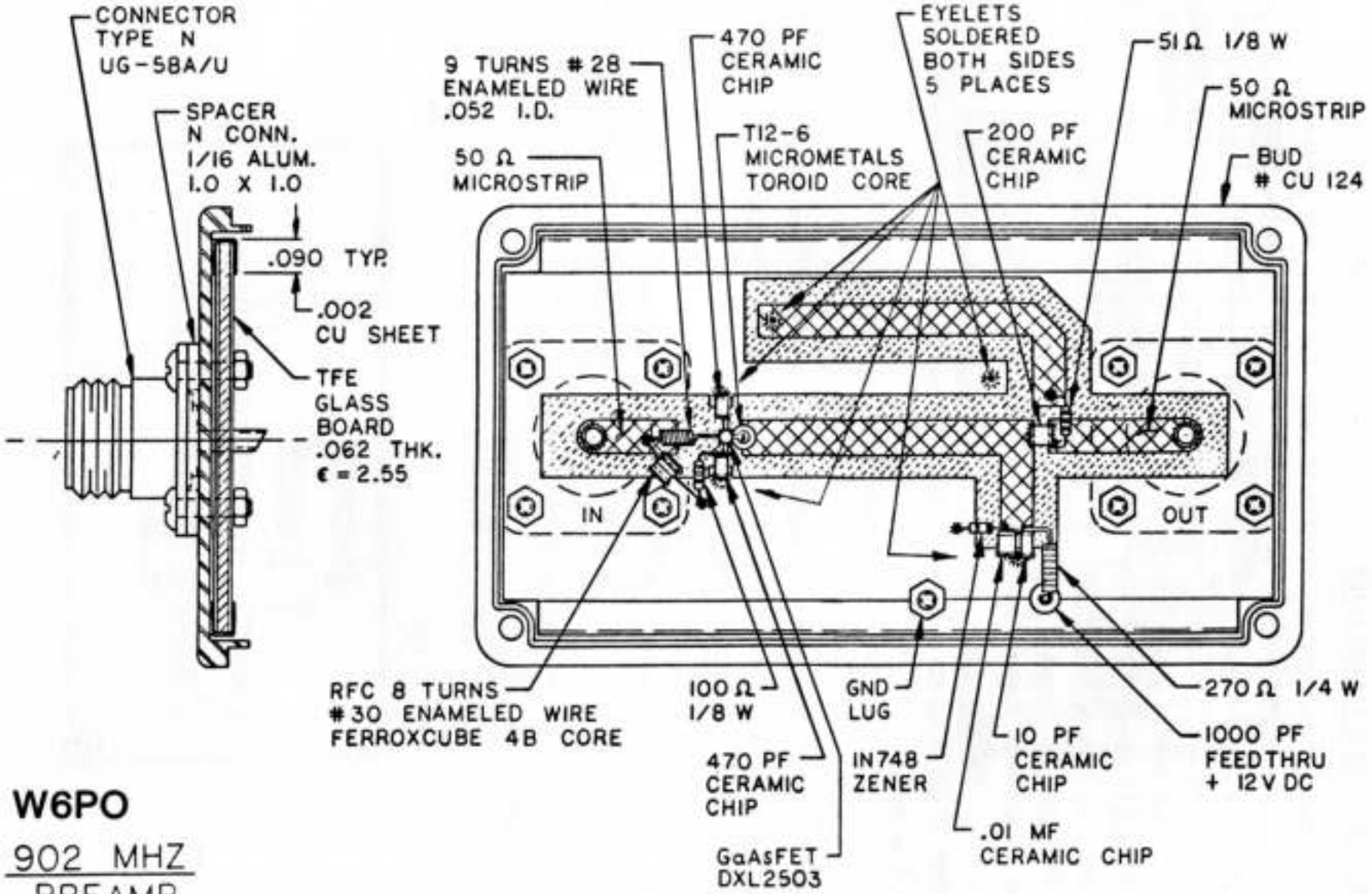
R2 — 51 Ω 1/8 W

L2 — 9 TURNS CLOSE WOUND
#28 ENAMELED WIRE
.052 I.D.

LS — INDUCTANCE OF SOURCE
LEADS ON GaAsFET

FB — T12-6 MICROMETALS
TOROID CORE

R3 — 270 Ω 1/4 W



W6PO

902 MHZ
PREAMP

902 MHz MICROSTRIP PREAMPLIFIER

The design procedure was exactly the same for this unit as for the 1296 MHz unit. Tests were run with the DXL2503 and VSF-9332. With the DXL2503 the gain was 19.5 dB and a noise figure of 0.5 dB. Also, with the DXL2503, the input return loss was 12 dB and the output return loss was measured as 27 dB. The MGF1400, MGF1200, D432 should work in this circuit quite well.

A circuit using the UG141/U technique was not constructed. However, such a unit could be made with the line length from the device to the 200 pfd. coupling capacitor of 1.64 inches. The stub from the capacitor to ground should be 0.457 inches long. With these line lengths, the MGF200, MGF1400 and D432 should perform quite well. The gate coil should start out at 9 turns #28 wire on a 0.052 inch form. A number 55 drill works very well. The coil is then adjusted while observing the noise figure.

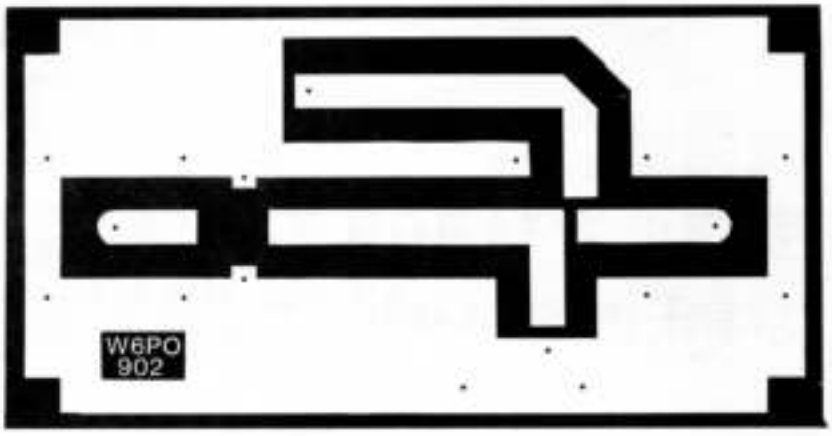


Figure 9

These pictures are of the artwork used to reproduce the microstrip boards for both the 902 MHz and 1296 MHz preamplifiers. It is possible to photograph these pictures directly to get a negative suitable for exposing a photosensitized board. Also, the board can be cut by an Exacto knife to the outline required. The unwanted pieces can be removed by heating with a soldering iron and pulling the copper foil off. A mechanical negative can be made by using Rubylith.

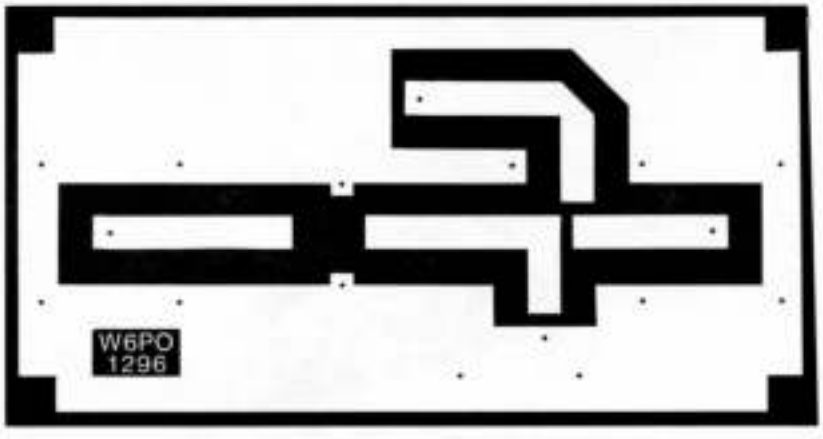


Figure 10