Quelques Watts sur 5,7 Ghz

F6DPH CJ96

Le 6cm est une bande très peu utilisée en France et même en Europe. L'OM intéressé par les Hyperfréquences a tendance à passer du 1296 Mhz ou 2300 Mhz directement au 10 Ghz, laissant de côté cette bande qui a des atouts importants. La bande débarrassée du guide d'onde imposant par le circuit imprimé sur verre téflon, les transverters, préamplis et amplis sont facilement réalisables et reproductibles. Les Fets fonctionnent très bien à cette fréquence avec une bonne stabilité et un gain important. Il en résulte une certaine facilité de construction et de réglage. Quant au trafic, beaucoup d'essais restent à faire. En contests, des multiplicateurs seraient les bien venus.

Pour résumer, le 6cm est une bonne base pour construire et trafiquer en hyper. Je renverrai les OM intéressés à la revue DUBUS (1) ou les équipements 5,7 Ghz sont largement décrits.

Mais revenons à nos Watts! Le prix raisonnable d'un Fet AsGa préadapté de 12 Watts en 7 Ghz (à Weinheim et à Auxerre) m'a permis de construire l'ampli décrit ci-dessous. La description se veut adaptable à d'autres opportunités et reproductibles. Le Mylar est disponible pour du verre téflon 0,8 et 0,5 (Er 2,5).

Description

a) Ampli

L'ampli se compose de deux transistors : MGF 2172 (2,5 Watts à 8 Ghz) et d'un FLM 6472-12 (12 Watts à 7 Ghz) placés dans des lignes 50 Ohms. L'adaptation se fait par positionnement de petits stubs. Le mylar ne tient pas compte des emplacements des transistors pour installer ce que vous trouverez...

b) Alimentation

L'alimentation largement décrite par DB6NT (2) est intégrée dans le boitier, elle est construite autour d'un LT 1083CP (7,5A réglable en tension), largement dimensionné, mais bon!... Avec les résistances indiquées, la tensions est de 9,5 Volts. Cette tension est coupée si le -5 Volts de Polar viendrait à manquer. La polar est réalisée par un 78L05 et un 7660. On peut utiliser des composants conventionnels ou des CMS.

c) Boitier

Le boitier est réalisé en alu fraisé avec une semelle épaisse. L'ensemble est très rigide! Tous les éléments sont fixés par des vis M2 ou M3 directement taraudées dans le boitier. L'emplacement des transistors est fraisé à la hauteur des pistes 50 Ohms du CI. Un morceau de mousse absorbante est collé à l'intérieur du couvercle. Un radiateur est fixé sur la semelle du boitier. Les prises d'entrée et de sortie sont des SMA.

Montage

L'état de surface du fond des emplacements des transistors et de la semelle où s'adapte le radiateur doit être très fin pour un refroidissement efficace. Il faut se servir du CI pour marquer les trous à percer et à tarauder. Ne pas oublier les quelques rivets de masse Ø 0,8. Le CI préparé est monté dans la boite en appliquant un peu de colle à l'argent (si vous avez!) et par les vis M2. Le régulateur est monté directement sur le fond de la boite par une vis M3. Montez tous les composants sauf les transistors, vérifiez les alimentations, et si la sécurité -5 fonctionne!

Avant de continuer le montage des AsGa, une petite bière est nécessaire (la bière annule les effets statiques, hé oui!)

Montez les transistors en prenant les précautions habituelles, boitier à la terre, fer débranché le temps de la soudure et l'OM à la masse (ça on savait!). Utilisez de préférence de la soudure pour CMS en pâte (seringue).

Réglage

Les transistors utilisés ont fait preuve d'une très grande stabilité. Réglez les courants comme indiqués dans les notices, injectez la HF, chargez et mesurez la puissance. Promenez des petits bouts de clinquants sur les pistes 50 Ohms, d'abord en sortie puis en entrée. Reprenez les réglages des courants pour le maximum de sortie. « Tune for max with out smog!». Avec 500mW d'entrée, la puissance de sortie est de 12 Watts

Pensez à inclure dans votre transverter un isolateur entre l'entrée de l'ampli et la sortie antenne. Quelques watts plus une bonne antenne entraine **un danger** pour vous et les personnes environnant l'antenne. **TAKE CARE**

Je remercie les OM qui m'ont aidés de près ou de loin à cette réalisation dont F5JEB, F5JBP.

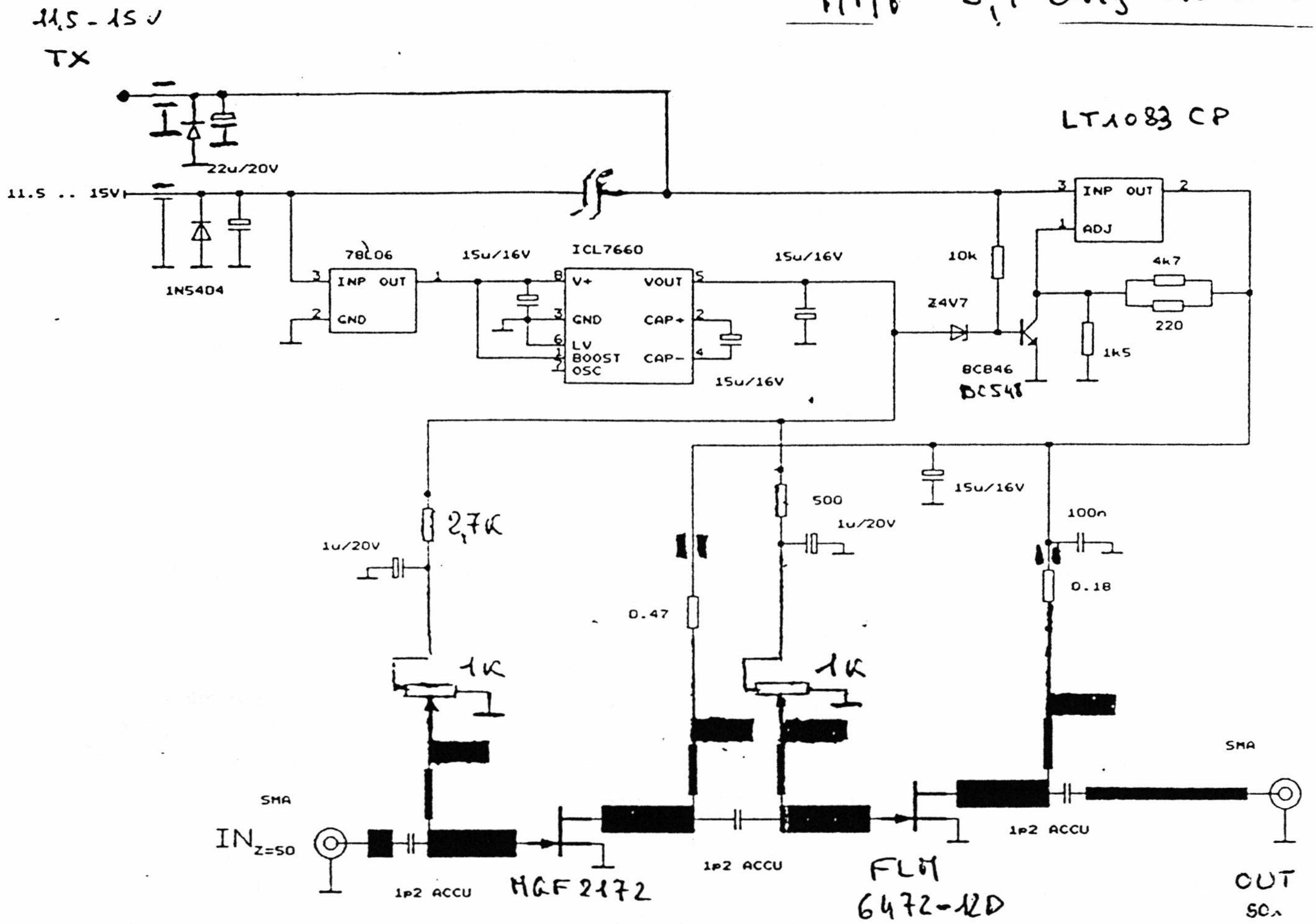
A bientôt sur 5,7 Ghz.

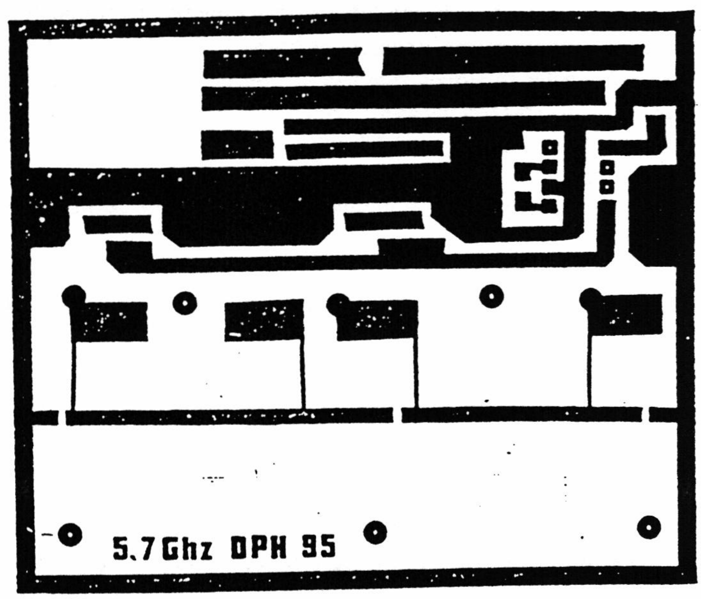
Philippe F6DPH

(1) DUBUS : Patrick MAGNIN, F6HYE Marcorens, F-74140 BALLAISON

(2) DB6NT : DUBUS Technik III

AMP 5,7 GHz 12W.

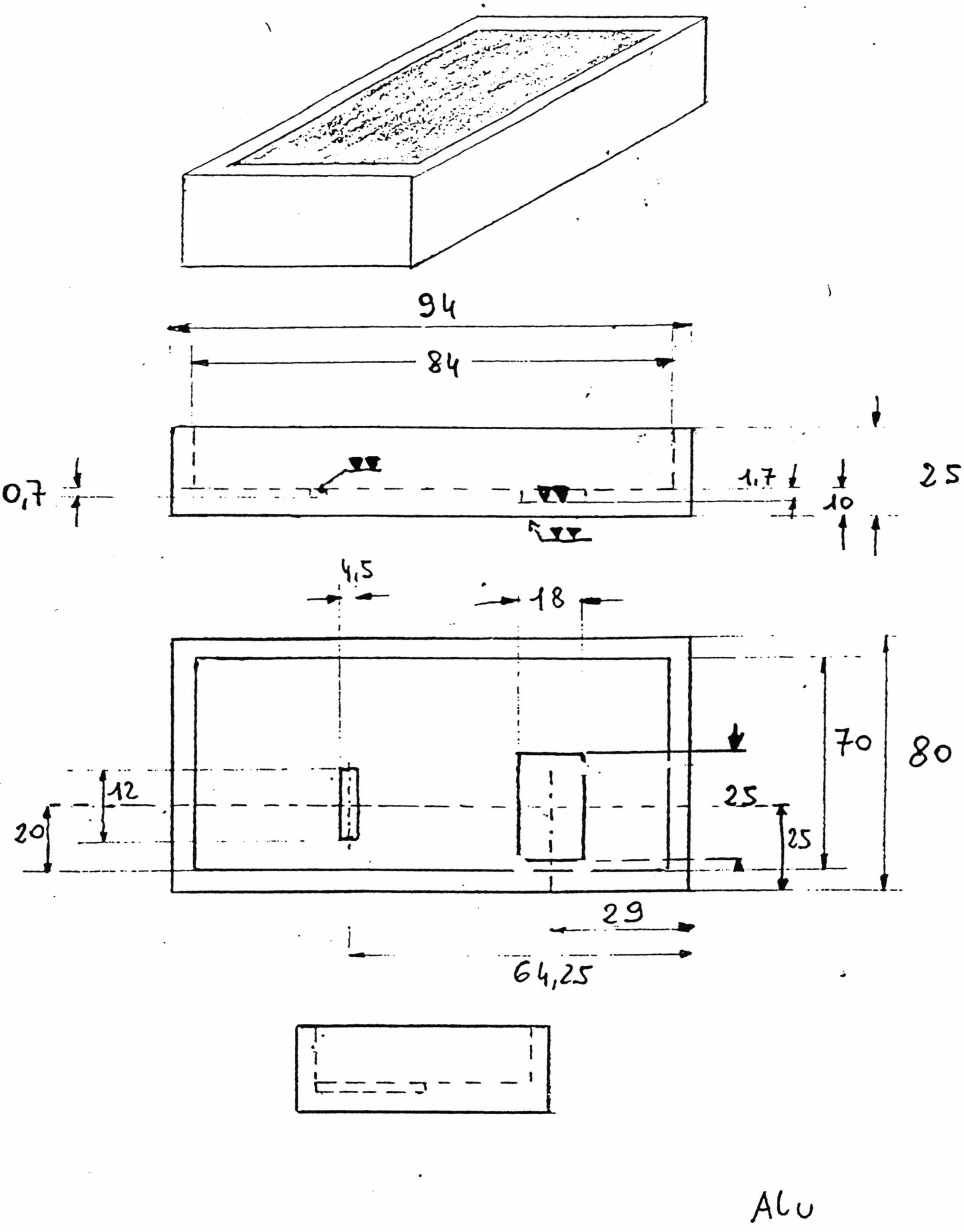


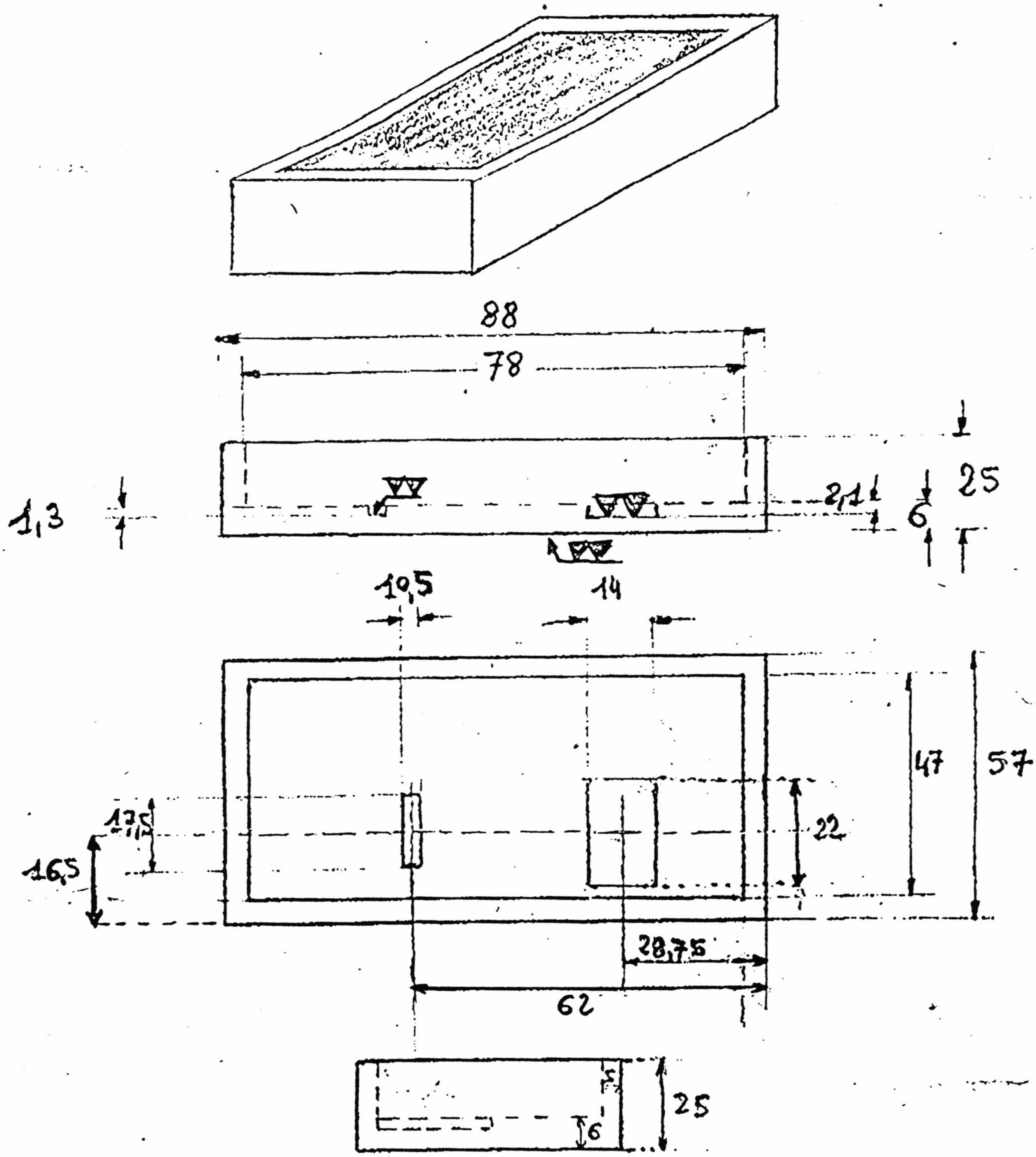


- Sources : DL2AM - DUBUS 1/95
  DB6NT - DUBUS TECHNIK III
  DL1RQ - VHF com. 1/95

SCHEMA BOITIER 5,7 Ghz 12W

Pas a l.Echelle





Boitier pour AMP 8 W 10 Ghz. ALU

DL2AM DUBUS 1/1995

F6DPH - CJ96

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A Solid State Power Amplifier for 5.7 GHz

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Abstract

A power amplifier based on combining low power GaAs FET devices to increase the output power is presented. A power supply that provides proper sequencing for the bias and drain voltages is also described.

Introduction

Early in 1987 Les Whitaker, W7CNK, and I decided to set up and run some EME experiments on 5 GHz. Shortly after our initial success with high power TWT's, both units suffered tube failure. We had to find a way to develop a moderate power output to replace the dead TWT's, or our moonbounce efforts would be QRT. After searching for a month or so, we could not find any replacement TWT's. It was decided to try and develop a solid state replacement.

About a year ago, Al Ward, WB5LUA, and I designed a power amplifier for 3.4 GHz using a pair of IMFET's. These are internally matched power GaAs FETS made by Avantek and several other microwave active device manufacturers. These devices are typically matched to 50 ohms on the input and output over about 500 MHz of bandwidth, and are available from about 2.9 GHz all the way up to approximately 14 GHz. Several devices are available that cover either the 3, 5, or 10 GHz amateur bands. Typical input and output SWR is 2:1 over the operating bandwidth in a 50 ohm system. These devices run class A, so current drain is fairly constant after the devices are biased on. Internally matched FETS are available from less than 1 watt out to in excess of 20 watts output. Most published specifications state the power output at the 1 dB compression point.

Power Amplifier

About the time we started looking at developing this amplifier, I was fortunate to obtain some surplus Avantek IM-5964-3 IMFETS. These devices are specified over the 5.9 to 6.4 GHz band with a nominal power output of 4 watts. By combining four devices we should end up with about 16 watts, minus the slight power losses of the circuit board couplers.

The amplifier was designed using one IMFET to provide the input drive to four IMFETS. Power division and summing is done using two-section branch line couplers. (See figure 1.) This is a 3 dB coupler and contains approximately one wavelength in circumference. These can be arranged in either a square fashion or a circle. At the higher frequency microwave bands, these are generally arranged in a circle to avoid sharp transitions. If drive is applied to port A and port D is terminated, we will get two equal amplitude signals out ports B and C, but with 90 degrees phase difference between them. This 90 degree phase difference occurs only at the design frequency of the coupler, and varies approximately 5 deg over a 10% bandwidth. Isolation from port B to port C should be better than 20 dB over this 10% bandwidth. This circuit works well for power division into reflective loads as the reflections of mismatch will be terminated into the load at port D. When combining two IMFETS using a pair of couplers, the 90 degree phase shift introduced on the input side must be removed on the output side. This is done by using the opposite port on the output coupler. (See figure 2.) By using a combination of power dividers and combiners, we take the output of the first IMFET and produce four equal amplitude signals. These signals drive the four IMFETS in the output stage, which by using signal combiners, all the power is summed back to a single RF out port.

Input and output lines to the IMFETS consist of 50 ohm microstrip. Bias lines to the gates are 1/4 wave RF chokes, with 1/4 wave stubs to provide additional decoupling. Gates are also fed through 47 ohm chip resistors and chip capacitors to suppress low frequency oscillations. Bias is provided from a -5 volt regulator and voltage divider. Do not supply gate bias from a low impedance supply as the resistor divider helps to limit gate current. Drain voltage is supplied by a small wire RF choke and bypass capacitor. Additional low frequency oscillation suppression is supplied by the series 47 ohm resistor and .001 uf chip capacitor. Use good quality chip coupling capacitors in the main RF port as RF currents present will vaporize low quality capacitors in short order. The PC board was mounted on a .25 inch thick plate with slots milled to allow the IMFET input and output leads to sit flush on the top circuit traces. This was then bolted to a large heatsink for cooling. Use static protection procedures when installing IMFET devices, as they are susceptible to ESD.

Power Supply

Proper sequencing of the voltage to the IMFET is necessary to prevent destroying the device. *Negative bias to the gate must be applied before drain voltage is applied.* Without bias applied, the IMFET'S can pull many amps of drain current, destroying the die or internal bonding wires on the substrate. The power supply should automatically prevent drain voltage being applied until the bias has stabilized. This bias voltage is also monitored and should a bias fault be detected, immediately shut down the drain supply.

The power supply uses a pair of DC-DC invertor IC's to supply the required bias, and a high current adjustable regulator to supply drain voltage. Voltage to the high current regulator, U4, is controlled by transistors Q1 and Q2, which act as a supply switch. When Q3 saturates, it pulls the base of Q2 low, which then saturates Q2 to provide base current for Q1. Transistor Q3 can be clamped off by either a bias fault detected in Q5, or by Q6, the amplifier enable transistor. Additional protection of the IMFETS is provided by Q4, which sets the voltage out of U4 to 1.25 V whenever the amplifier is disabled. Normally the regulator output voltage goes to zero when disabled, but if Q1 and Q2 should short and the bias fail, this should help limit power dissipation in the FETS.

Power is applied to Q1 and Q2 whenever voltage is connected to the amplifier power supply. The power switch controls the bias supply and voltage for enabling Q1 and Q2. Be sure to heatsink Q1 and U4 as they dissipate about 30 watts when using the Avantek IMFETs. Additional diodes are used in the negative supply to prevent the gates from ever being driven positive or from excessive negative voltage. A 0.1 ohm resistor is used in the drain supply lead to each FET so the current can be monitored.

Alignment

Thoroughly test the power supply before connecting it to the power amplifier. Simulate the IMFET load by using a 120 ohm resistor on the negative gate supply, and a 7 to 8 ohm 10 watt resistor for each IMFET drain load. Connect +13.8 volts to the supply and turn on the power switch. There should be negative 5 volts on the 120 ohm resistor, and zero volts on the drain load resistor. Enable the amplifier by pulling the enable line low. Adjust the voltage regulator pot for +9 volts on the drain load resistor. Open the power switch and check to see that the drain voltage goes to zero. Close the power switch and load the negative gate bias output with additional 120 ohm resistors in parallel until the bias drops to about -3 volts. Check to be sure the drain voltage goes to zero under this low bias condition. The threshold of cut off is set by the pair of 300 ohm resistors going to the base of Q5. When the power supply has been tested, connect it to the amplifier. With a good 5 GHz load connected to the amplifier output, enable the drain voltage. Check that each IMFET idles about 1.2 amps with a drain voltage of +9 VDC. Apply input drive of 1 watt maximum and check power output. If everything is correct, power output should be about 16 watts. Check IMFET heatsink temperature for proper heat conduction.

Conclusion

To date we have built a pair of these amplifiers. They were etched on .031 inch thick Duroid 5880, ER=2.3. With 700 milliwatts drive, the first amplifier put out 16.5 watts, the second put out 17.2 watts. A pair of these will then be combined to provide about 32 watts for each of our EME stations. These will be mounted at the dish feed, and will give us about the same power we had running the TWT's, but without the feedline loss. Thanks to Les Whitaker, W7CNK, for building and testing the first two units. They were works of art. Also, thanks to Allan Bundens, N5FZF, for assistance in producing the computer generated PC board artwork.

References

Howe, Harlan, "*Stripline Circuit Design*", Copyright 1974 Artech House, Inc.

Avantek, *1985 Semiconductor Device Catalog*, Avantek, Inc.

IMFET is a trademark of Avantek, Inc.

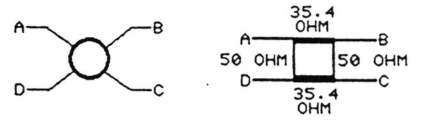


FIGURE 1

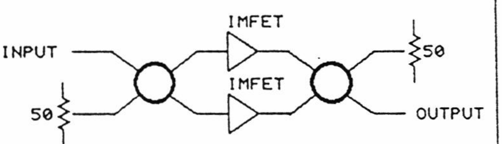
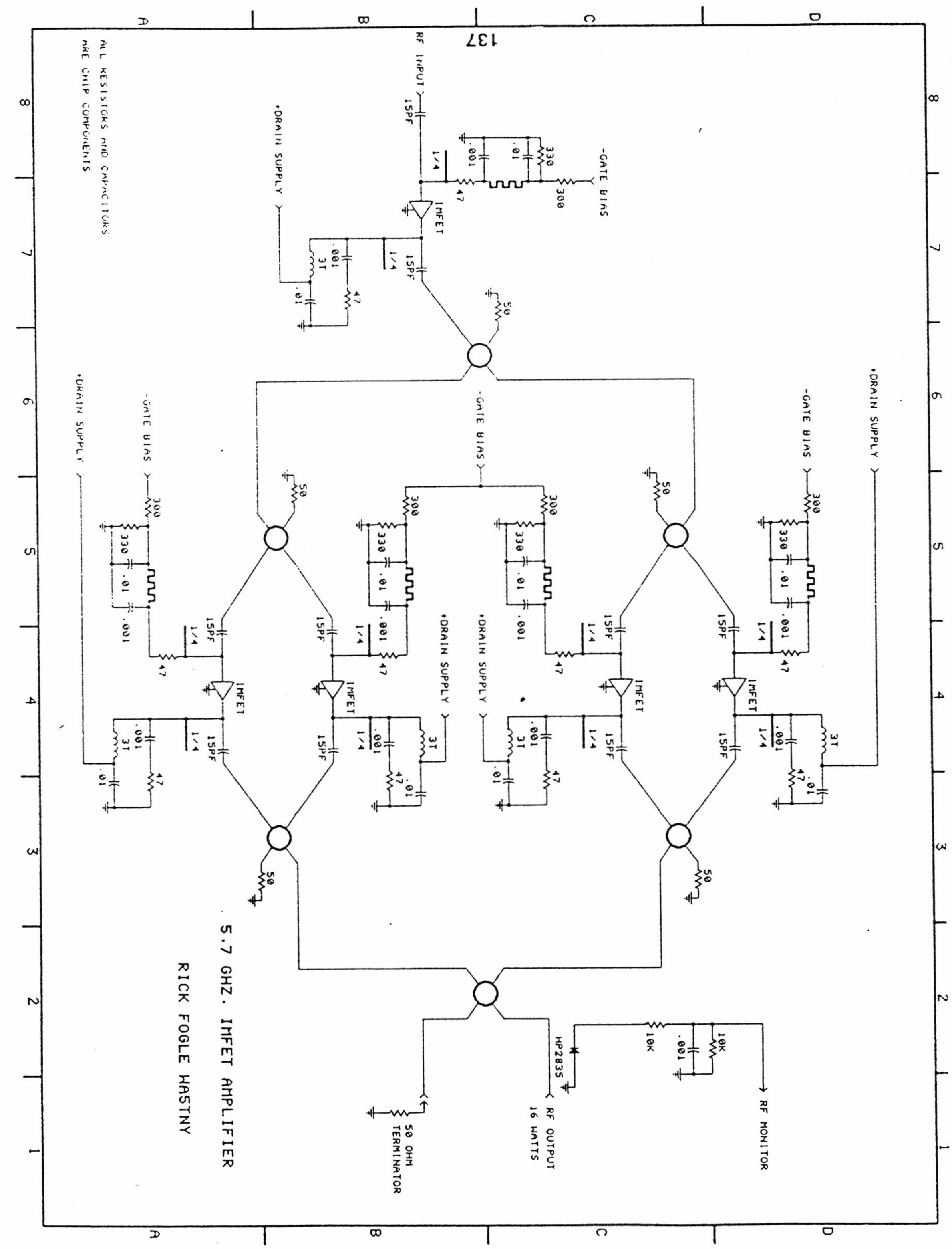


FIGURE 2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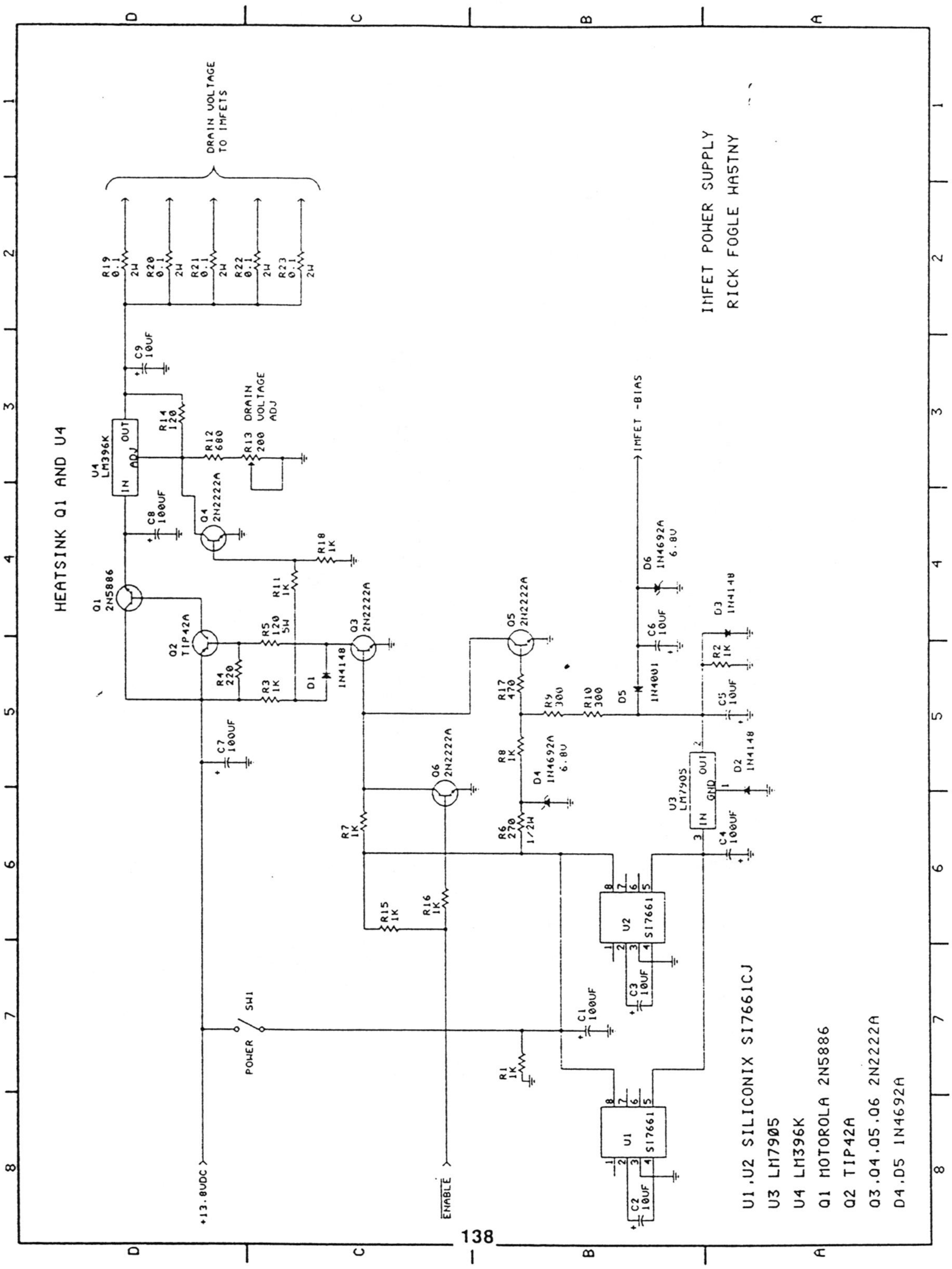
RF INPUT
ALL RESISTORS AND CAPACITORS ARE CHIP COMPONENTS
+DRAIN SUPPLY
-GATE BIAS
IMFET
5.7 GHZ. IMFET AMPLIFIER
RICK FOGLE HASTNY
50 OHM TERMINATOR
RF OUTPUT 16 WATTS
HP2835
RF MONITOR


IMFET POWER SUPPLY
RICK FOGLE WA5TNY
HEATSINK Q1 AND U4
DRAIN VOLTAGE TO IMFETS
DRAIN VOLTAGE ADJ
IMFET -BIAS
POWER
SW1
+13.8VDC
ENABLE
U1,U2 SILICONIX SI7661CJ
U3 LM7905
U4 LM396K
Q1 MOTOROLA 2N5886
Q2 TIP42A
Q3,Q4,Q5,Q6 2N2222A
D4,D5 1N4692A
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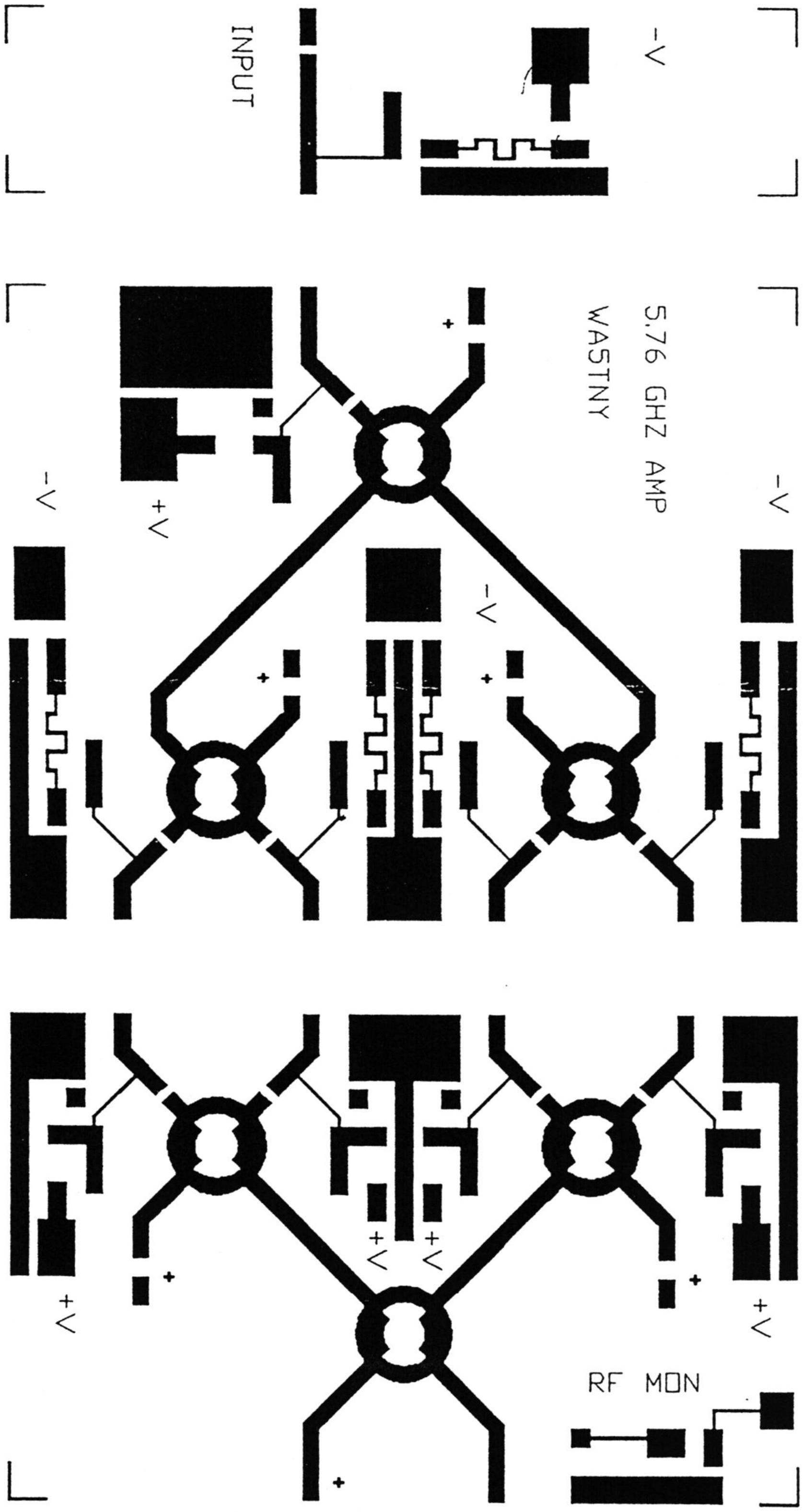

INPUT
-V
5.76 GHZ AMP
WASTNY
+V
RF MON