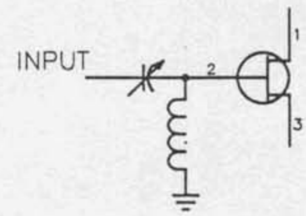
GaAs FET Pre Amp Cookbook #3
Kent Britain WA5VJB

There are many designs for building preamps, each with their own advantages and disadvantages. By putting together an input, bias, power supply, and output, you can optimize a preamp for your station. My thanks to W5ETG, N5QGH, and AA5C for their help.

Inputs: The input network transforms 50 Ohms to the input impedance of the GaAs FET. At VHF a typical GaAs FET has about a 3000 Ohms input impedance. A High Q circuit is usually used to transform the impedance up and at the same time filter out unwanted signals.
As frequency increases, the GaAs FET input impedance drops to a few dozen ohms at 10 GHz. HEMT's have an even higher input impedance, almost 5000 Ohms at VHF, dropping to 50 Ohms at 11 GHz. Here we will talk about 11 common input circuits.

#1
Advantages: Low Parts Count
Low loss

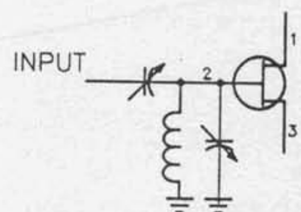
Disadvantages: Optimal noise match is a matter of luck.



This is one of the simplest input circuits and works nicely up to 1296 MHz. A true match from 50 Ohms to the Gamma opt, or best Noise Figure condition for your GaAs FET depends on the stray capacitance from the Gate to Ground.

#2
Advantages: Optimum match
Variable Q (See tuning)

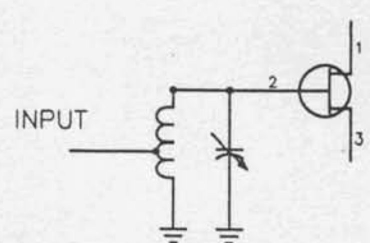
Disadvantages: Needs two high quality trimmers
Tuning interacts



This is the most popular input circuit for high performance preamps below 500 MHz. Due to the high input impedance of the GaAs FET below 500 MHz the Q or Bandwidth of the input circuit can be varied with little cost to Noise Figure. See the Tuning Tips diagram.

#3
Advantages: Extremely low loss
Input is at DC Ground

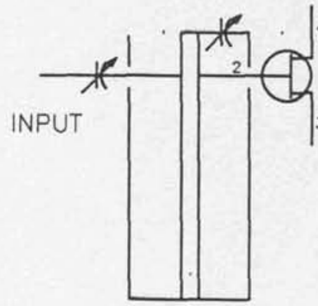
Disadvantages: Extremely wide Bandwidth
Only matches low impedance GaAs FET's MGF1801, 2116 etc.
Limited to 50, 144, and 222 MHz

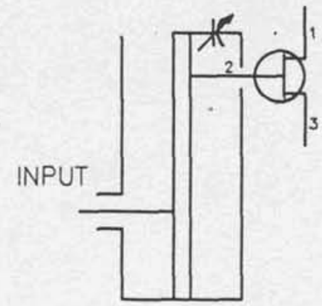


The tapped L input is used in the high performance preamps using power GaAs FET's on 144 and 222 MHz. The relatively low input impedance of the X-Band power devices allows this low loss input network to be used. While good with the MGF1601/1801/2116 devices, performance has been disappointing with MGF1302 or ATF10135 devices. At microwave frequencies, the input impedance of a HEMT drops low enough for a similar tapped L circuit to be used.

#4
Advantage: High Q

Disadvantage: High Q

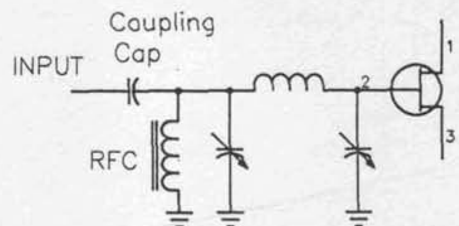




Cavity inputs combine an input matching network with a High Q cavity. This will have less loss than simply trying to put a cavity filter in front of a conventional preamp. The capacitor input cavity can be easily tuned for a variable Q, or bandwidth like the 2nd input circuit. By tuning C1 to a lower value, the cavity has less loading that a much tighter bandwidth. The tapped cavity usually has less loss, but finding the optimum tap point can be a lot of trial and error and a lot of machining. Typically the best tap point will be about 30% up from the grounded end of the cavity. The cavity is slightly shorter than 1/4 wavelength. Typically .20-.22λ

#5
Advantages: Matches virtually any impedance.
Simple

Disadvantages: Requires two high quality trimmer caps.
Care must be used in picking the values for the input coupling cap and the RFC values.



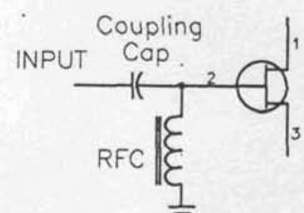
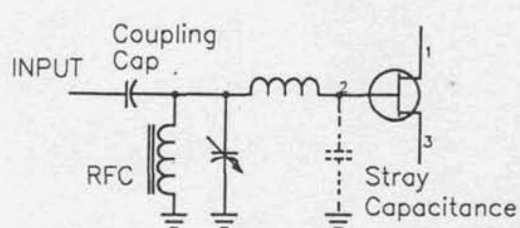


Fig. B

The Pi input works from HF to 3.4 GHz. While it has been successfully used in 2 Meter EME preamps, it is normally found in 902 and 1296 MHz preamps. If a large value blocking cap is used and a high value RFC, the 2 pf in the trimmers and the short piece of wire for L1 become negligible, so the circuit converts to Fig B. at low frequencies. Fig B is a simple HiPass filter with a low end cut off as low as 1 MHz. I have personally had a 1296 MHz Pi input preamp wiped out by an AM broadcast station.

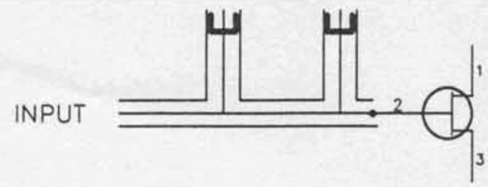
#6
Advantages: Only one trimmer

Disadvantages: Optimal match is a matter of luck



The half Pi circuit will often match certain devices at a specific frequency. Typically the second trimmer tunes at a very low value because of the stray capacitance in the GaAs FET. Under these conditions, the second trimmer can be eliminated with little effect.

#7

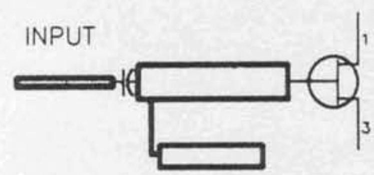


Advantages: Extremely versatile, capable of matching most any impedance

Disadvantages: Very large assembly below 1 GHz
Difficult to supply bias voltage
Difficult to build.

The double stub tuner is the best method of providing an impedance match. But construction difficulties and expense limit these to lab work and device evaluation.

#8

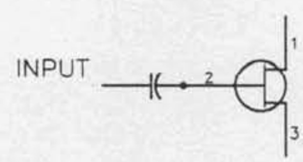


Advantages: Reproducible using PB board techniques
Repeatability

Disadvantages: Limited to microwave frequencies
Limited to one device at one frequency
Beyond most hams ability to calculate and fabricate.

In stripline circuits, striplines of carefully calculated length and impedance are used for impedance matching. Typically the results are good for only one device at one frequency and require time consuming artwork and expensive materials. But if someone goes through all this trouble, large quantities of high quality preamps can be easily mass produced at modest cost.

#9



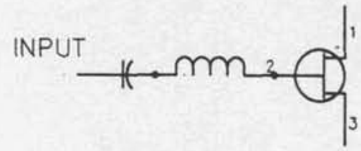
Advantages: Simple and low loss

Disadvantages: Good for only a limited number of devices at certain frequencies

As the input impedance of the GaAs FET falls with rising frequency, there comes a point were the input is near 50 Ohms. Many GaAs FET's were designed to have a 50 Ohm input impedance at 3.7 to 4.2 GHz for TVRO and lately many HEMT's are designed for 50 Ohms input impedance at Ku Band for Satellite TV.

#10

Advantages: Simple and low loss
Low parts count
Broad bandwidth
Excellent Noise Figure



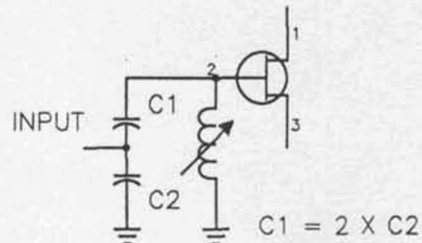
Disadvantages: Broad Bandwidth
Limited to .9-2 GHz Range

Just a small amount of inductance in the gate lead can impedance match several devices in the 1 to 2 GHz region. This form of matching was used in the W6PO designs for 902 and 1296 MHz. The big disadvantage to this circuit is using it in metropolitan areas. The gate is directly connected to the antenna and is subject to all strong signals. In practical applications, a filter is often placed ahead of the preamp or some form of tuned stub is added to the input to remove strong out-of-band signals. Loss in this filter can negate the advantage of this input circuit.

#11

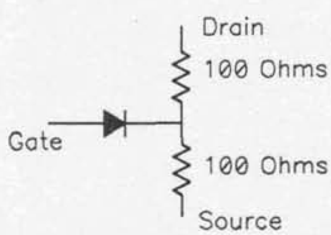
Advantages: Cheap
Easy to tune

Disadvantages: Optimal noise match is a matter of luck

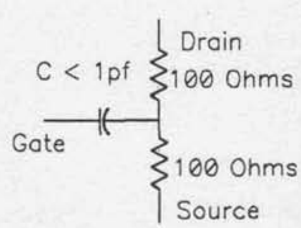


The tapped capacitor input is used in some of the kit GaAs FET preamps. This design eliminates the expensive trimmers and an inexperienced builder only has to tune one slug to peak performance. With the typical +/- 20% tolerance capacitors, you can expect good, but rarely top performance. Typically C1 is about twice the value for C2

Biasing: The input of a GaAs FET is a small Schottky diode. The input of a HEMT is basically a small tunnel diode. This diode is so small that it can only be seen under an electron microscope. In normal operation this diode is negatively biased, effectively making the gate a low value capacitor.

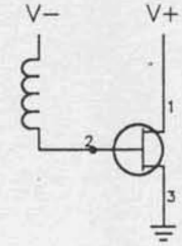


DC Equivalent Model of a GaAs FET



RF Equivalent Model of a biased GaAs FET

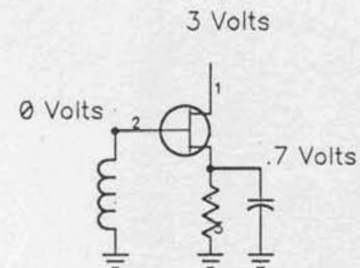
There are two common ways to supply the required negative voltage to the gate of a GaAs FET.



Advantages: Direct grounding of the source
Excellent control of all DC parameters

Disadvantages: The negative supply must turn on first and turn off last.
Complex power supplies

This method requires power supplies more complex than the preamp. But direct bias is the preferred method of getting the most out of a design.



Effective Bias on the Gate
−.7 Volts

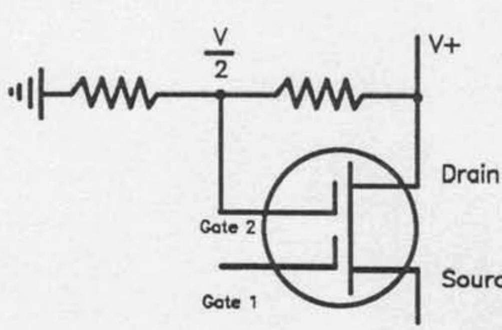
Advantages: Only one positive supply needed
Thermal run-away virtually eliminated

Disadvantages: The source must be heavily RF by-passed

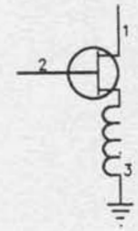
The self-bias circuit was a popular way of making a tube "think" its grid was negatively biased. The voltage drop across the source resistor raises the substrate of the device above DC ground. Now grounding the gate gives it a reverse bias. The device also operates in a current limiting mode, more current gives a greater negative bias to the gate, turning off the device. The challenge comes in making the RF part of your circuit think the source is really grounded and the gate really isn't. Low inductance leadless ceramics, or chip capacitors are used to RF bypass the source. RF Bypassing becomes increasingly difficult at microwave frequencies.

Dual Gate Devices:

The second gate on a dual gate GaAs FET is normally used for AGC/Gain control of the preamp stage. With Japanese devices such as the 3SK97/121/124, NE411, NE251, and MGF1100, gate 2 is normally run at half the drain voltage. American devices such as TI's S3030 and Motorola's MRF 966 operate gate 2 at 1/4th to 1/3rd the drain voltage. Except for biasing of the second gate, all other circuits in this paper are applicable to both single and dual gate GaAs FET's.



Source Inductance:



Advantages: Improved input matching
Lower Noise Figure
Improved stability

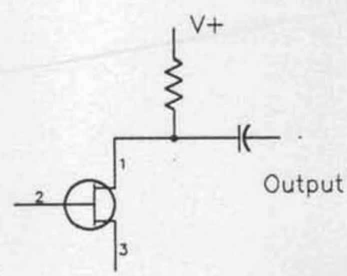
Disadvantages: Reduced stability

There has been quite a bit of work by Chip Angle N6CA and Al Ward WB5LUA using the feedback from small amounts of source inductance to improve stability and input matching. This Source Inductance can be a small coil, but usually the leads of the GaAs FET itself are left unusually long. Normally source inductance reduces stability and should be avoided. But if someone has gone through the effort to find the optimal source inductance for a device at a frequency, USE IT!

Output Circuits: The output circuit matches the output impedance of the GaAs FET to the next stage or 50 Ohms. The output circuit also separates the RF from the power supply.

The output match affects Noise Figure, Gain, and circuit stability. There is no one best output circuit for all devices at all frequencies under all conditions, but here are 9 common output circuits.

#1

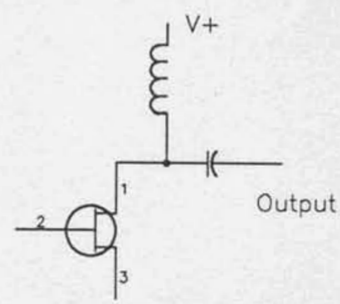


Advantages: Simple
High stability
Low parts count

Disadvantages: Low circuit gain
Usually no device matching

Just a dropping resistor and a capacitor is about as simple as you can get. Be sure the resistor is a non-inductive type and that you have RF bypassing on the opposite side of the resistor. Typically this circuit will have 6 to 8 dB less Gain and a few tenths of a dB higher Noise Figure than a matched output at VHF frequencies.

#2



Advantages: Simple
Low parts count

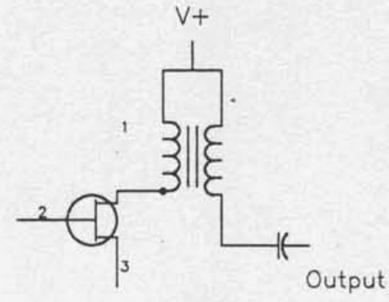
Disadvantage: No device matching
Stability problems

While simple and higher stage gain than a resistor, the RFC and the Capacitor tend to form a resonate circuit at some frequency. Normally this is not a recommended circuit.

#3

Advantages: Broad frequency response
No tuning
Self shielding

Disadvantages: Broad frequency response
Poor matching
Lower gain and higher N.F.

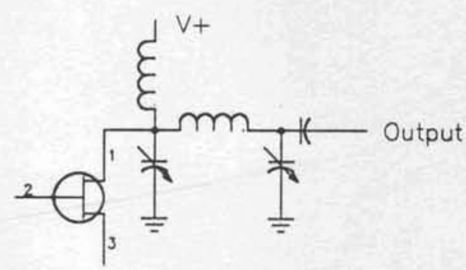


The 4 to 1 transformer has been used since the first W6PO designs and the self shielding of a toroidal transformer simplifies layouts. Modern GaAs FET's tend to have an output impedance of about 1000 ohms at VHF frequencies. So the 4 to 1 transformer is ideal only for a 200 to 50 ohm match. Motorola improves this by suggesting 9 to 1 transformers for the MRF966. Also at upper VHF and lower UHF frequencies, the transformer tends to look more like an inductor than a transformer. Care must be taken in Ferrite selection for the core. Optimal Gain and Noise Figure matching can be difficult to obtain.

#4

Advantages: Excellent Matching

Disadvantages: Needs a lot of "Real Estate" below 1 GHz
Coupling problems with the input

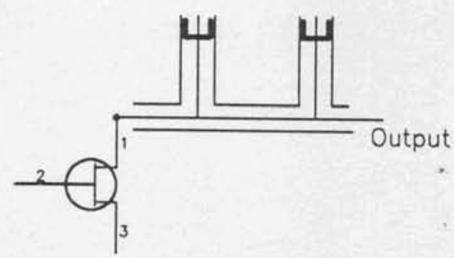


Normally the Pi output is limited to 1296 and 2304 MHz. The trimmer closest to the device usually tunes at min. capacitance and can often be eliminated. While this circuit has been used as low as 144 MHz, care must be taken to prevent coupling between the input and output circuits at low frequencies.

#5

Advantages: Extremely versatile
Capable of matching most any impedance

Disadvantages: Very large assembly below 1 GHz
Difficult to build with hand tools

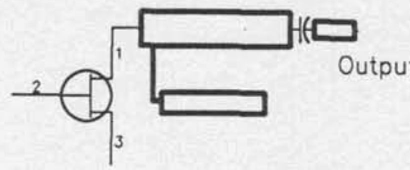


Again the double stub tuner is unquestionably the best method of providing an impedance match. While rarely used by hams due to size and construction problems, this is the normal method of characterizing GaAs FET's at the factory.

#6

Advantages: Reproducible using PC Board techniques

Disadvantages: Limited to microwave frequencies
Only for 1 device at 1 frequency
Beyond most HAMS ability to design

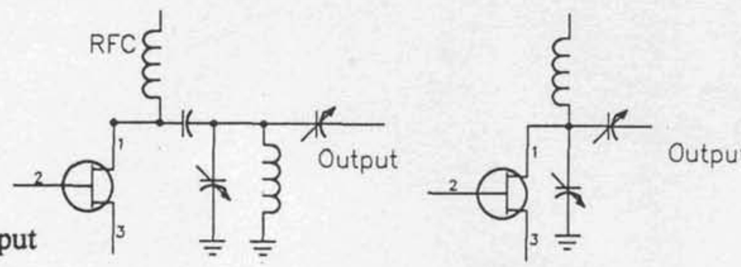


Again in stripline circuits, stripline of carefully calculated length and impedance are used for matching. Typically the results are good for only one device at one frequency on one type of material. But once the work is done, large quantities of high quality preamps can be easily reproduced.

#7

Advantages: Excellent matching
Narrow bandpass

Disadvantages: Coupling problems with the input
Tuning interaction

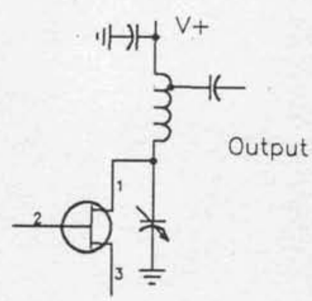


This is the most popular output circuit among hams and manufacturers in Japan. Tuning can be a bit tricky since the trimmers interact with each other. Power can be bypassed using a feedthru cap and fed though the coil. (A) Or the circuit is often turned around putting the coupling capacitor between the device and the tuned circuit. Power is then fed through an RFC directly to the Drain (B).

#8

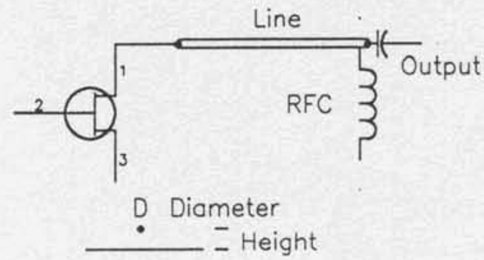
Advantages: Excellent matching
Narrow bandpass

Disadvantage: Coupling problems with the input



This is my personal favorite for VHF and UHF preamps. The tapped inductor provides impedance matching and can be easily moved to different points for different devices. The tuned circuit helps reduce out of band interference. But care must be take in construction to reduce coupling with the input inductor. Winding the input and output coils in opposite directions, mounting the coils 90 degrees to each other, shielding the coil, and keeping the coils physically small are but a few of the methods to reduce coupling.

#9
Advantages: Simple



Disadvantages: Can take up a lot of room
Really only useful on 902, 1296, and 2304 MHz

Impedance of the output line:
Zo = 138 Log 10 (Height / Diameter)

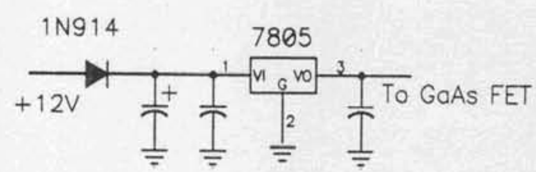
This circuit is the dead-bug equivalent of a Stripline circuit. The impedance of the wire parallel to an infinite plate can be calculated. Thus with a known impedance and electrical length, an impedance transformation can be accomplished. So just a few inches of wire about 1/4" above the ground plane becomes a tuned circuit. The RFC has quite a bit of stray capacitance to ground and can be attached at different point along the line to improve matching. With Dual Gate devices such as the NE411/251, the RFC should be attached near the GaAs FET. For Single Gate GaAs FET's like the ATF10135 or MGF 1302, the RFC should be attached at the end of the line My thanks to Norm WA8EUU for showing me this circuit.

Power supply/Voltage Regulation

Most GaAs FET's like 3 to 5 volts DC at 10 to 20 milliamps. It's nice to have this supply stable, free of spikes and current limiting. In the typical station, reducing spikes is more important than voltage regulation. GaAs FET's will often tolerate 25 to 50% changes in voltage with little variations in Noise Figure or Gain, but voltage spikes from relay coils and nearby lighting strikes can quickly destroy the device.

Three Terminal Regulator:

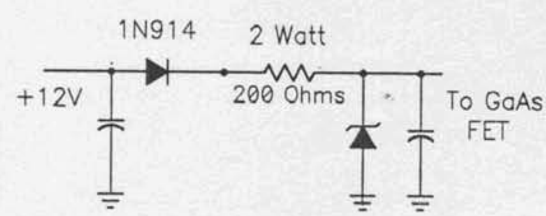
Advantages: Simple and Compact
Good Voltage Regulation



Disadvantages: Failure mode puts full voltage on the GaAs FET
Can pass voltage spikes

Resistor and Zener:

Advantages: Absorbs high intensity spikes
Failure modes shorts the supply to ground protecting the GaAs FET
Common Components
Reverse Polarity Protection



Disadvantages: Consumes more power
Needs more space

Construction and Operating Tips:

Always leave the Pre-amp Powered Up!

Many believe they are protecting the GaAs FET by turning it off while transmitting. ***WRONG!***
When operating, the gate of the GaAs FET is negatively biased about .5-.7 volts. The FET is damaged when the Gate has a positive voltage and conducts current. So you need enough RF to overcome the negative bias before it can be harmed. Typically it takes 4 times as much RF leakage to damage a power upped GaAs FET than a turned off GaAs FET.

Short Leads. It doesn't take a very long piece of wire to become an antenna at 10 GHz and radiate RF (And Trouble) all around your preamp.

Coils: Wind the input and output coils in the opposite sense, i.e. one right handed and the other left handed. This will greatly reduce mutual coupling. Mount the coils 90 degree to each other. This will also greatly reduce mutual coupling. Keep the coils small. A small coil has a more localized field and less coupling to other circuits.

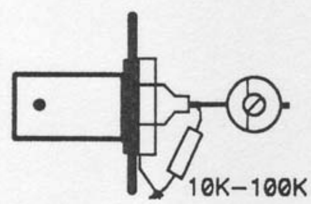
Ferrite Beads: Ferrite beads behave as both and RF Absorber and a Low Q RF Choke. The absorption increases with frequency, so a carefully placed Ferrite Bead can be used to absorb microwave parasitics while passing 144 MHz signals. At 432 MHz I have used half of a bead (cut lengthwise and glued on) with success. See a typical Impedance profile of a Ferrite Bead in the appendix.

Connectors: Type N or SMA connectors should be your first choice for the input connector. BNC's your second choice. Leave the SO239's on your HF rig. The output connector is not really critical to the system Noise Figure.

Construction: Put the GaAs FET in last as you construct your preamp. Use a Grounded or cordless soldering iron if possible. If you have a regular 2 wire soldering iron, let it get hot then unplug it while actually soldering in the GaAs FET. You really don't want 120 VAC capacitively coupled from the heating element to your expensive and delicate FET. When handing the GaAs FET, always pick it up by the Source or Drain leads, never the more static sensitive Gate lead.

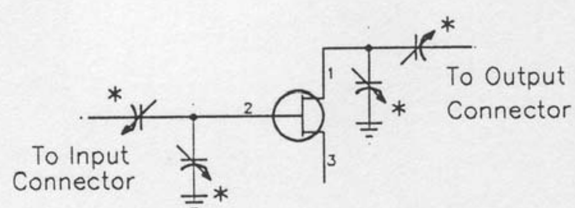
Static Charge Dissipating

If your antenna system is not a direct DC short, put a 10K to 100K static bleeder resistor from the input connector to ground. This keeps a static charge from building up on the antenna, arcing across the trimmer cap and zapping the FET.



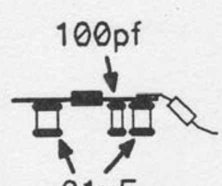
Trimmer Caps

AT VHF and UHF, the high impedance point are the inputs and outputs of the GaAs FET.
Just touching these points with your tuning tool can change the tuning.
Mount the trimmers so that the rotors are to ground, or to the connectors.

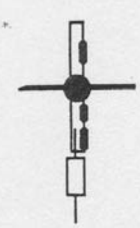


Bypass Caps:

With self-biased preamps, the source is RF bypassed to ground with 100 pf to .1 uF capacitors. Most capacitors have a frequency where they look like a tuned circuit (Self Resonate). If you are concerned about self resonance, you can bypass the bypass caps.
That is, put a small value cap across a large value cap.



Front View



Top View

Absorber: **Works great! Till you put it in the box!**

Two factors are working against you when you put your pre-amp in the box.
First, the box tries to become a cavity at some frequency and you've ended up building a cavity oscillator. Second, the box is about the same size as microwave waveguide. Let's see, 10 GHz waveguide has about 3 dB/100 ft of loss, so how much loss is there in your 3 inch box?

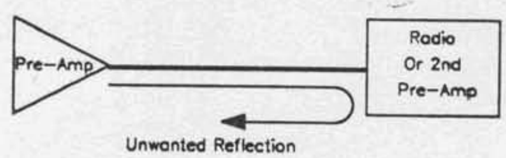
The box itself becomes a nearly lossless transmission line.

Sheet Ferrite absorber really breaks up this feedback path. Usually a 1/2" by 1/2" piece glued to the bottom of the box is all you need. The black conductive foam IC's are often packed in works almost as well. About a 1" by 1" or larger piece can be glued in the bottom of the box. The Foam has a habit of crumbling with time. I usually put a layer of Clear Spray paint or RTV over the foam to hold it together.

Reverse Polarity Protection: Always put a diode in series with your preamp. Most any diode will work, a 1N914 or a 1N4148, or even something from the 1N400X family. The diode protects the preamp from the reverse polarity spikes from relays, and protects it from *you* during those little wiring accidents that happen during DXpeditions and late night QSO's

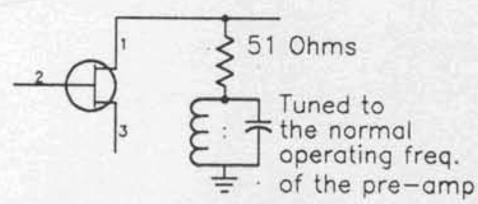
Output Attenuators:

The input of a radio is tuned to see 50 Ohms, but the radio itself does not look like a 50 Ohm load. So most radios have a high SWR on the input. The RF energy can reflect back to the preamp and start an oscillation. Usually about 3 dB of attenuation is enough to stop this oscillation.
Several feet of RG58 or RG174 is especially good as an attenuator. The coax has far more than 3 dB of loss at the microwave frequencies were the oscillation often occurs.



Resistive Stabilization:

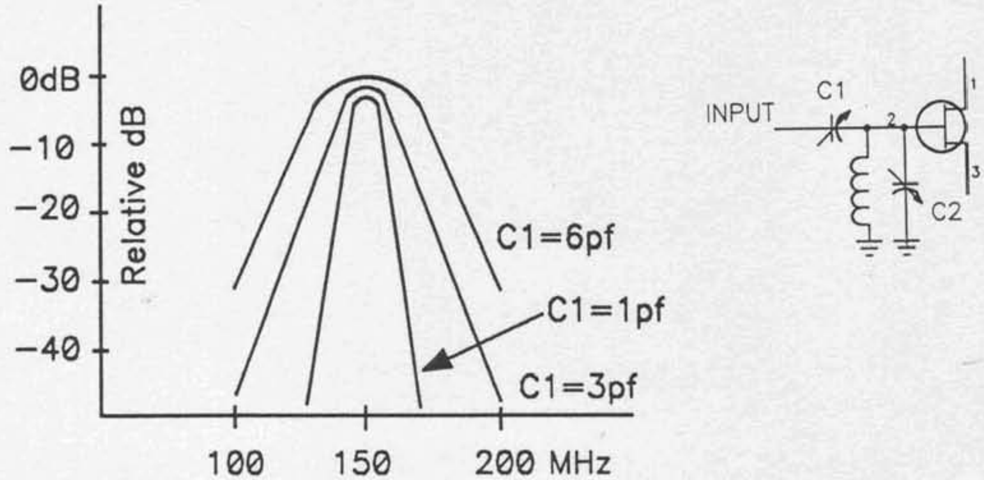
This is a common circuit added to the output section of many European Preamps. The parallel tuned circuit has a very high impedance on the operating frequency of the pre-amp. So at 144 MHz on a 144 MHz preamp the circuit has ≈10K + 51 Ohms of resistive loading. This effectively takes the 51 Ohm resistor out of the circuit.
At frequencies other than 144 MHz, the series tuned circuit looks like a short circuit and the 51 Ohm resistor is across the output.
Now, from DC to GHz, (Except at 144 MHz) the preamp is operating into a 51 Ohm load.
In microwave stripline circuits the 51 Ohm resistor is often included in the bias voltage and drain power supplies to give the preamp a 51 Ohm load at low frequencies.



Component Layout:

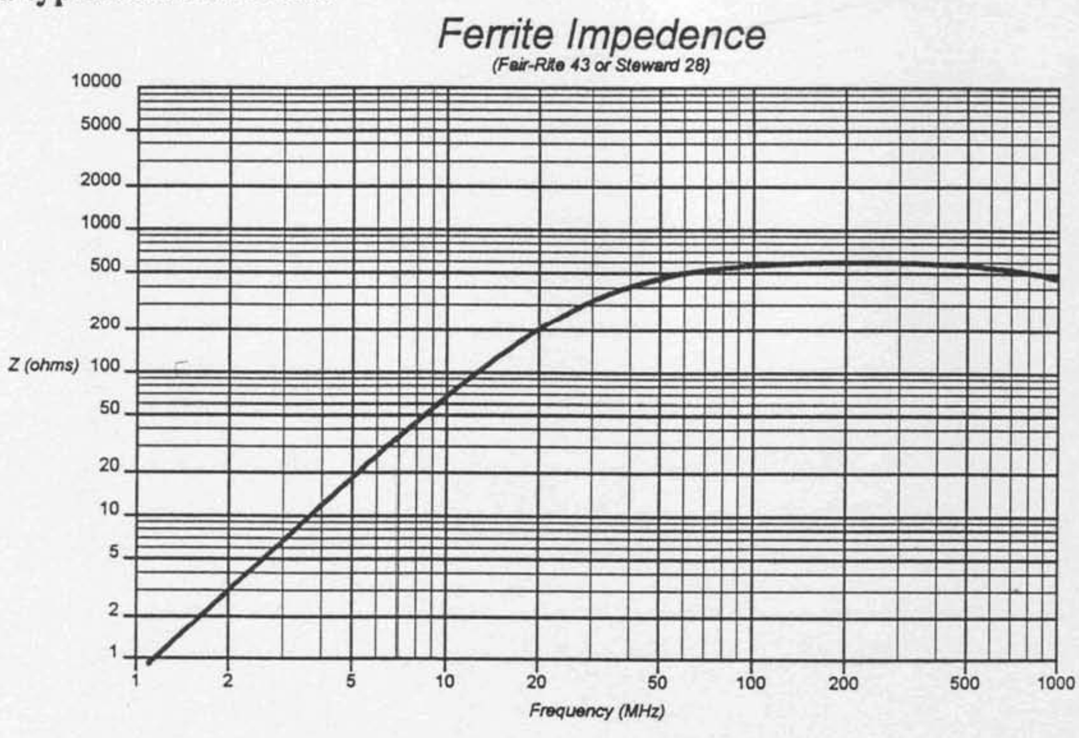
Where a component is mounted, is almost as important as the quality of that component.
While too broad a subject for discussion here, I suggest looking at the GaAs FET preamps published in the 1984-1994 ARRL Handbooks. Photos of proven designs are shown.
Just follow the general layouts.

Tuning Tips:
This is the most commonly used input circuit for VHF and UHF preamps. The Q or bandwidth of this circuit is highly affected by the setting for C1. When tuned for best Noise Figure on 144 MHz, the typical values for C1 is about 6pf and C2 is also about 6 pf. But if tuned for less coupling, i.e. reduce the value of C1 and re-resonate the circuit by increasing the value of C2, the Q of the tuned circuit goes up and the Bandwidth decreases.



As you can see, intentional mistuning the input can give 20 dB more rejection of FM Broadcast stations and upper VHF TV stations. This mistuning will cost a half dB or so of Noise Figure, but this is less loss than the typical filters. Note: You don't always want to tune for best Noise Figure or highest gain. (TNX to W5UN for making me figure this one out.)

Plot of a typical Ferrite Bead:

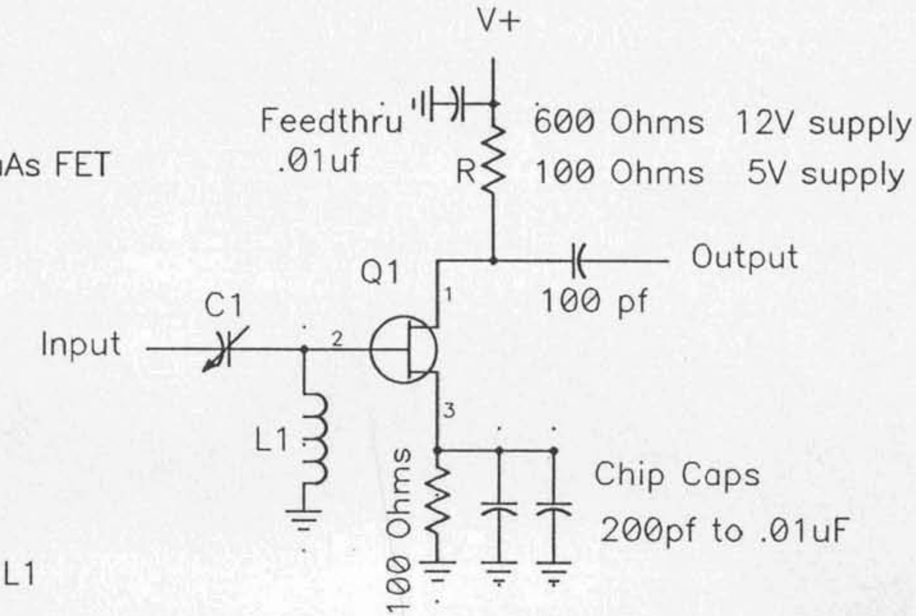


Circuits: OK, lets take all these circuits and combine them like the choices from a "Blue Plate Special" Menu.

Just About as Simple as You Can Get

Input #1—Self Bias—Output #1

Q1 Any Single Gate GaAs FET



	C1	L1
50 MHz	2–10pf	10 turns 1/4" slug tuned
144 MHz	2–10pf	8 turns 3/16" dia
222 MHz	2–10 pf	5 " "
432 MHz	2–10pf	3 " "
902 MHz	.3–3pf	Brass Strip 1/8" wide 1/8" high 1.5" long
1296 MHz	.3–3pf	Brass Strip 1/8" wide 1/8"high 1.1" long

All coils 18–22 guage solid Copper wire

I don't think you'll win any Noise Figure contests with this. Gain will be a bit low, but it will work fine where limited space is the biggest problem. WA5VJB

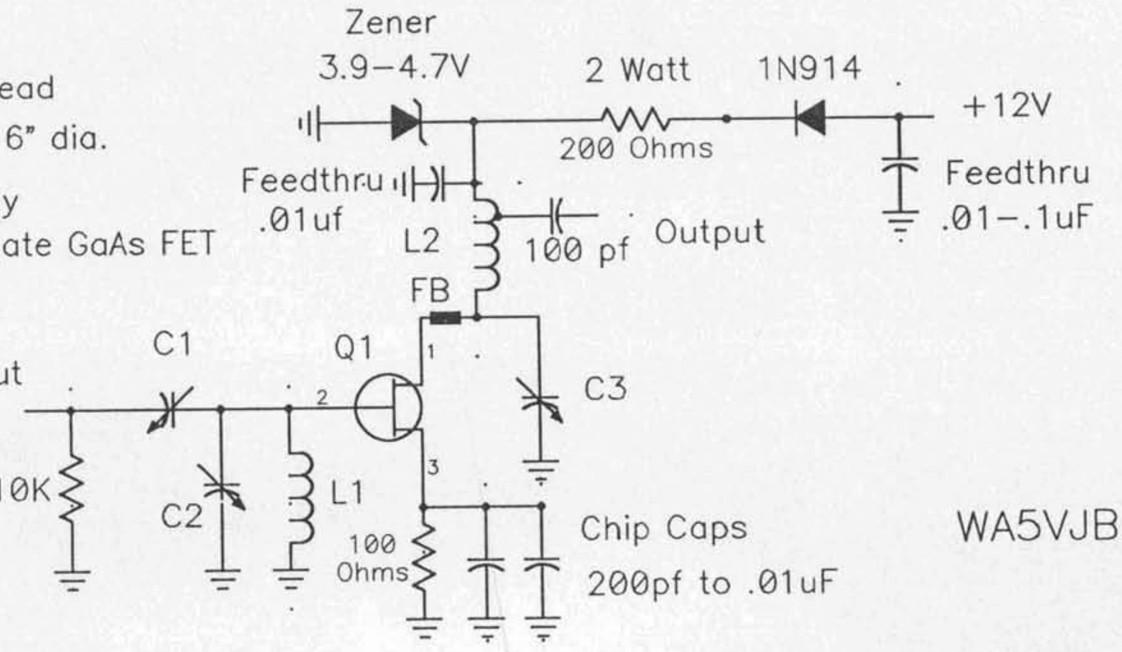
Conventional Design

Input #2—Self Bias—Output #8

FB Ferrite Bead

All Coils 3/16" dia.

Q1 Most any single gate GaAs FET



WA5VJB

Band	C1—C2	C3	L1 turns	L2 turns	L2 tap turns from cold end
144	1—10pf	4—40pf	9	4	1
222	1—10pf	1—10pf	6	3	1
432	1—10pf	1—10pf	4	2	1/2

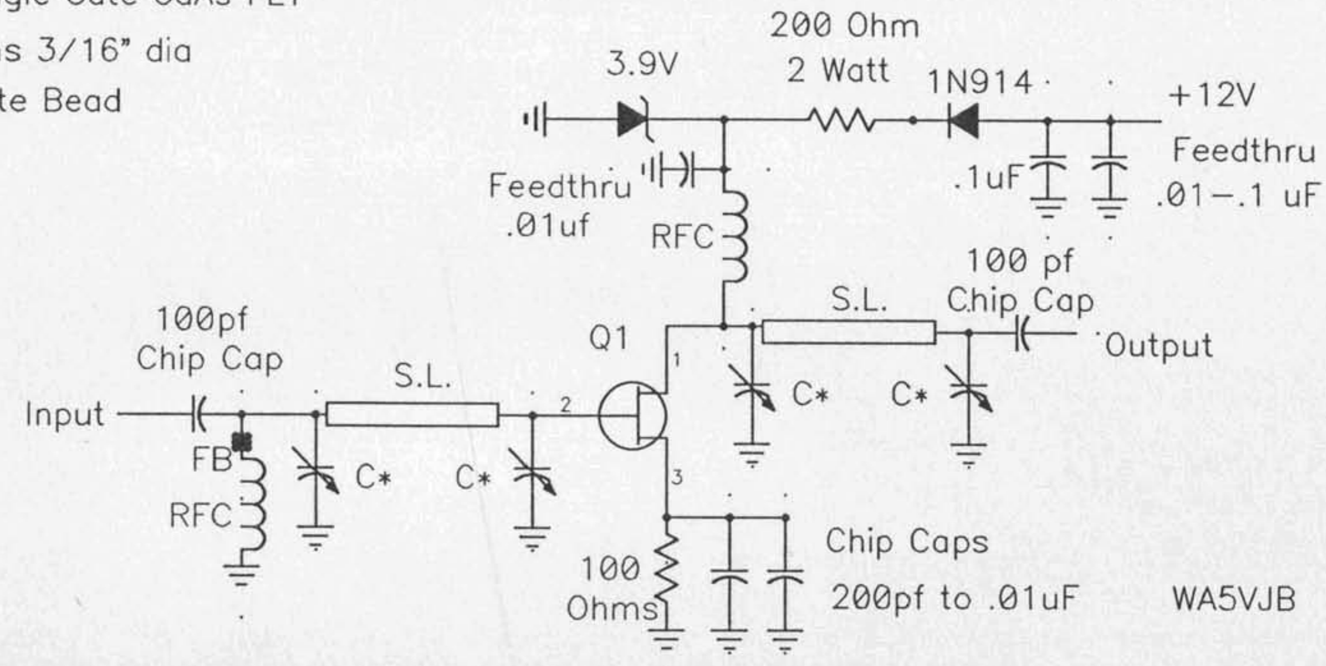
All Coils made from 18—22 guage solid Copper wire.

High Q Input, High Q Output and a Power Supply that takes a lot of abuse.

This design is a proven perfomer in RF polluted environment s on dozens of repeaters, packet nodes, and EME stations. WA5VJB

Pi In Pi Out

Q1 Any Single Gate GaAs FET
RFC 6 turns 3/16" dia
FB = Ferrite Bead



WA5VJB

	C	S.L.
902 MHz	.8–10pf	.25"wide 1.3"long .2"high
1296 MHz	.8–10pf	.25"wide 1"long .2"high
2304 MHz	.3–3pf	.25"wide .5"long .2"high

Strip Lines
made from .020 or .032"
sheet hobby brass

Power GaAs FET Preamps

Kent Britain WA5VJB

Adapted from DUBUS 95/3

Since the designs for Large Gate FET's were first published in Dec 1990 by the VRZA EME Newsletter, the designs have been improved and we have a better understanding of the circuit. My thanks to WB5LUA, who has done extensive computer models and precision measurements of the input circuits.

There is nothing magical to the MGF 1801's. Extremely low noise preamps have been built with the MGF-1601, MGF-2116, NE0800, and many Avantek power devices. For the typical MFG-1302 style GaAs FET the 1/f curves predict device noise figures of .02 to .05 dB in the VHF region. However, Gamma Opt (Best Noise Figure Match) typically rises to over 3000 Ohms. The loaded Q of the input matching has .3 to .4 dB of loss transforming the impedance from 50 Ohms to 3000+ Ohms. HEMT's have an even lower noise figure at VHF, but matching to the higher Gamma Opt has even more loss.

By using a GaAs FET with a 800u wide gate vs. a 250u wide gate, the Gamma Opt drops to about 900 Ohms at VHF. This allows a lower Q, lower loss, input matching network. The MGF-1801 has a higher device Noise Figure than a MGF-1302, but the matching network has far less loss!

For the last 7 years, these designs have consistently given .1 to .25 dB Noise Figures at Noise Figure Contests. .1 to .15 dB for the 50 MHz versions, .1 to .25 for the 144 MHz versions, and .2 to .25 dB for the 222 MHz versions has been very consistent. At 432 MHz the Noise Figures rise to .5 to .7 dB and these designs are not competitive.

Fig. #1(*Cookbook Input #3*) is the most commonly used input circuit. The tapped L input consistently gives .1 dB lower Noise Figures than a cavity input. This design has been used by KB8RQ on 144 MHz EME for 5 years with excellent results. Currently, 8 North American EME'ers are using one of these Preamps.

Fig. #2 (*Schematic Insert*) is the lowest loss input circuit, but the 3 dB bandwidth is over 50 MHz. The preamp has gain from 25 MHz to 350 MHz making the preamp useless in any urban environment.

Fig. #3 (*Cookbook Input #4*)is the cavity input circuit. The cavity is used for both impedance matching and filtering. This is the circuit I personally use. My QTH is 10 km from 18 Television transmitters and I trade an extra .1dB of input loss for more out-of-band rejection.

Fig. #4 (*Cookbook Input #4*)is the tapped cavity. The tapped cavity has less loss than the Capacitively coupled cavity, but it can be difficult to find the best tap point. With the capacitive coupled cavity, the input capacitor can be tuned to a lower capacitance, increasing the cavity Q, trading Noise Figure for a tight bandwidth. This is very useful in high EMI areas such as my QTH.

C Band waveguide makes an excellent cavity. Theoretically 72 Ohms is the best impedance for the line, but cavities ranging from 30 to 120 Ohms have been built with little difference in Noise Figure.
KH6CP has had good luck using sections of 1/2 inch Heliax to build up tapped lines for his inputs.

A straight Voltage Regulator is not recommended. Many of these devices are capable of 1 watt output if the preamps oscillates! Current limiting resistors protect the device and your receiver. A voltage adjustment will help when tuning for that last .1 dB.

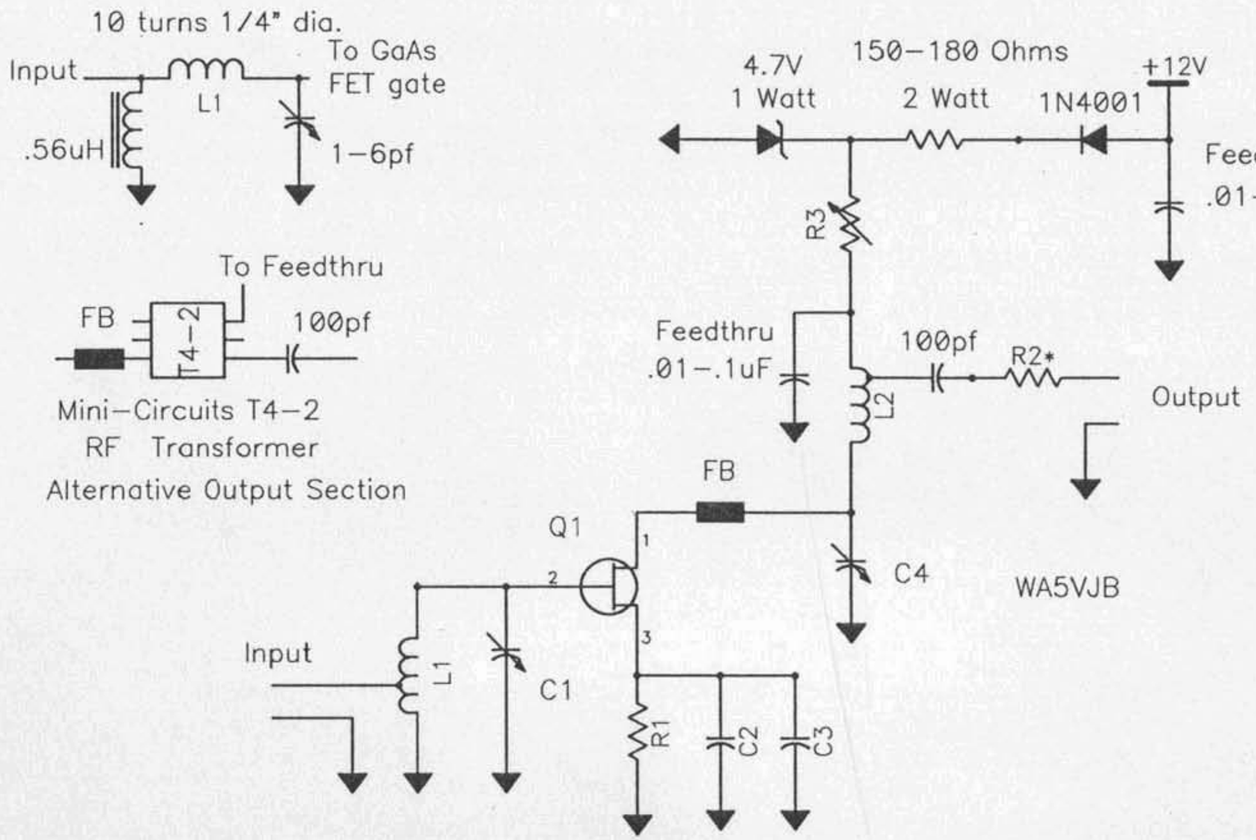
A 4 to 1 transformer does not match the outputs of these 800u GaAs FETs very well. While a transformer does work, a tapped, Low Q tuned circuit works better. The tap point on the output inductor can be moved for best match. Be sure to wind the input and output coils in opposite directions.

These designs have been empirically developed during the construction of over 40 PowerFet preamps. We have not been able to computer model and entire preamp. The GaAs FET manufactures just don't publish the 150 MHz Noise Parameter data for their 1/2 watt 10000 MHz devices!

My thanks to Henk Ripet for first publishing these designs, and to Al Ward, WB5LUA for analysis and cleaning up my technical points.

Power FET Preamp

Alternate Input
Not recommended - See text

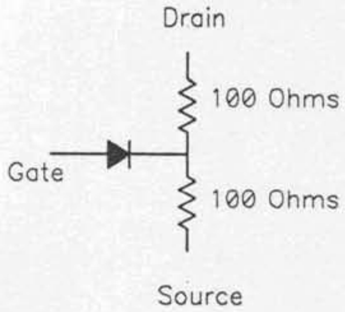


C1 10pf piston trimmer
C2,C3 Chip caps 200-1000pf
C4 4-40 pf trimmer
R1 27 Ohms MFG1601
22 Ohms MGF1801/2116
R2 Optional stability resistor
10-27 Ohms 1/4 watt Carbon
R3 50-200 Ohm trim pot
adjust for best N.F.
L1 14-16 guage wire 1/4" dia.
L2 18-22 guage wire 3/16" dia.

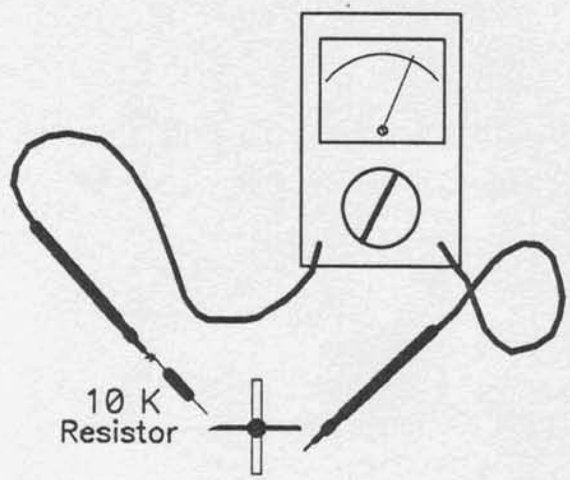
144 MHz	L1 10 turns tap at 3 turns
222 MHz	L1 7 turns tap at 2 turns
Same for 144 & 222 MHz	L2 3 turns tap at 1 turn

Q1 MGF 1601 Or any FET designed for
1801 .2-1 watt output in the
2116 microwave bands.

APPENDIX #2



Resistive Model
of a GaAs FET



Analog VOM with a 1.5 Volt Battery

Testing GaAs FETS:

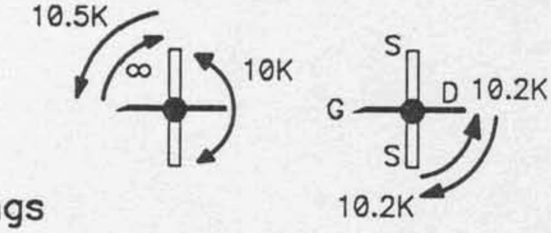
When I first saw WB5LUA make this test, I gasped, but it makes sense.

Use a VOM with a 1.5 Volt battery!!
No 9 V powered DMM's or 22 Volt Simpsons allowed here.
This is a great place for that old $5 Radio Shack VOM.

1.5 volts is less than the break down voltages of the gate, so it won't hurt anything. The 10 K resistor limits current to .1 ma, and that's not enough current to hurt the gate. Just zero your meter, put in a 10K resistor on one lead, and add 10K to all the resistance readings. Some of the older FET's used the Slashed gate as the Drain. You can use this test to make sure you're putting the FET in the right way. For an in-circuit test, just unsolder the gate lead, or unground the input coil. Now check the gate for 10.5K one way, and ∞ the other. 99.99% of the time, if the FET's been zapped, the gate is gone.

As always, take precautions against static electricity.

Kent Britain WA5VJB

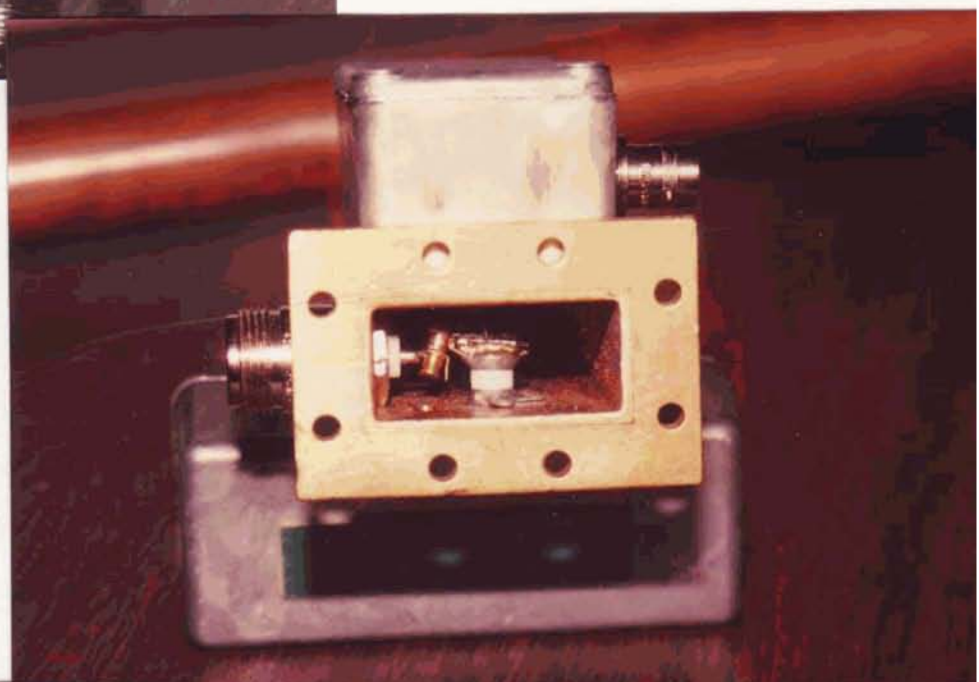


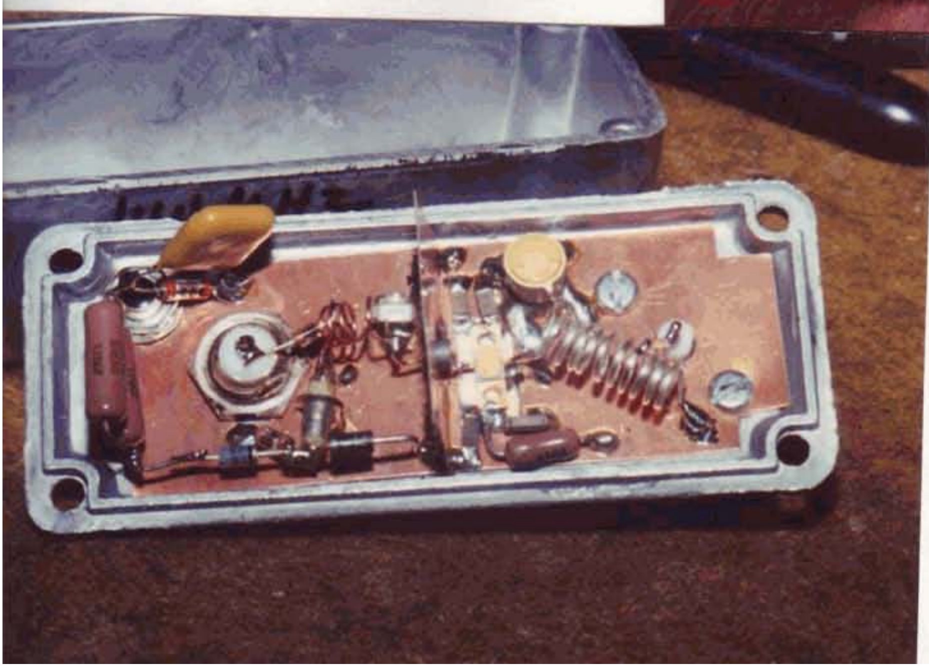
Typical Readings

Photos

MGF-1801
Cavity
Style

Input Connector
and Coupling
Capacitors





MGF-2116
Mounted on electrically
Isolated Heat Sink