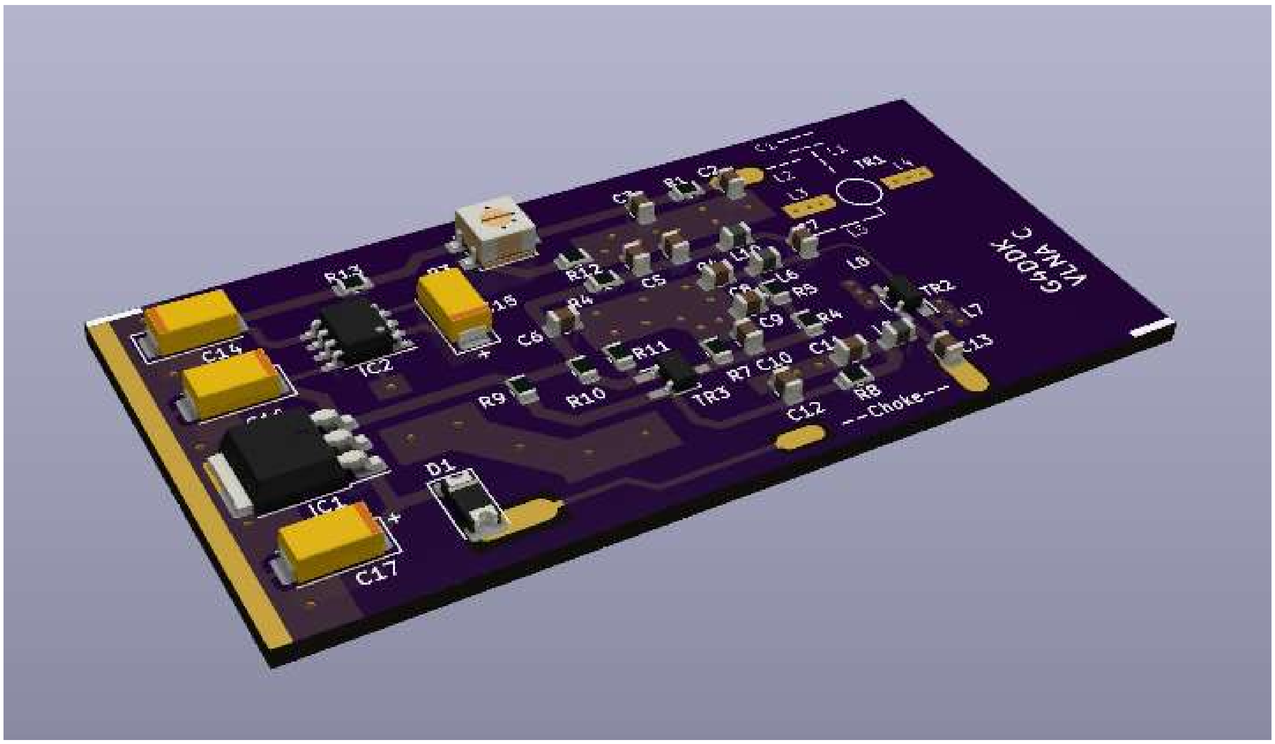
An updated VLNA for the 23cm and 13cm amateur bands [1]

By G4DDK



The original PCB Gerbers are no longer available. They had been produced using Eagle version 4.0 and later modified by a board-house to remove an error of mine.

I had decided to learn Kicad. Version 7 had just been released and this proved an easy package to learn, after Eagle, especially with the in-built 3D viewer. The result was the VLNA C board. A quantity of these were built up for test and proved satisfactory on 23cm but required some rework to use on 13cm. Subsequently a further change was made. These were retained as VLNA C board and the picture above is of that board. Several dozen of the ealier C version of the board have made it into the 'wild' and with a simple modification and a component placement move (cut and strap) work quite well on 13cm (S Band).

The principal changes to the board were to replace the fiddly 0603 size SMD parts with the larger 0805, adding more room around the input to ease soldering the L1 and L2 coils in place, making proper provision for a DC bias choke to enable power feeding over the output coax, some recalculated matching between TR1 and TR2, to reduce some of the excess gain at 23cm and finally an attempt to get the K factor below 1 across the complete frequency range so that the absorber material would no longer be required.

My attempts at improving stability were partially successful. I had leant early on that the absorber was needed to suppress the tendency of TR1 to self oscillate at about 6.5GHz, when used with the optimum source inductance (those fine source wires) for lowest noise figure. The absorber next to the input series inductance to TR2 proved to be the answer, with no longer any need for absorber on the end wall. This reduced the amount of absorber material required. I continued to place absorber in the lid as a sort of belt and braces approach.

With this approach I am able to achieve the same 0.25dB noise figure (yes, I know…..) at 23cm and now only slightly higher at 13cm. The gain is still above 30dB at 23cm and around 25dB at 13cm and accross the whole of S band. Input return loss is 10dB or better.

It is possible that a different HEMT could be used in place of the MGF4919, which is now obsolecent. The MGF4941 has been used successfully in 9cm versions of the original VLNA. At the time of writing these have not been tried in the 23cm version. Substituting a different device would almost certainly require some rework to the values of the input noise matching network on 23 and 13cm.

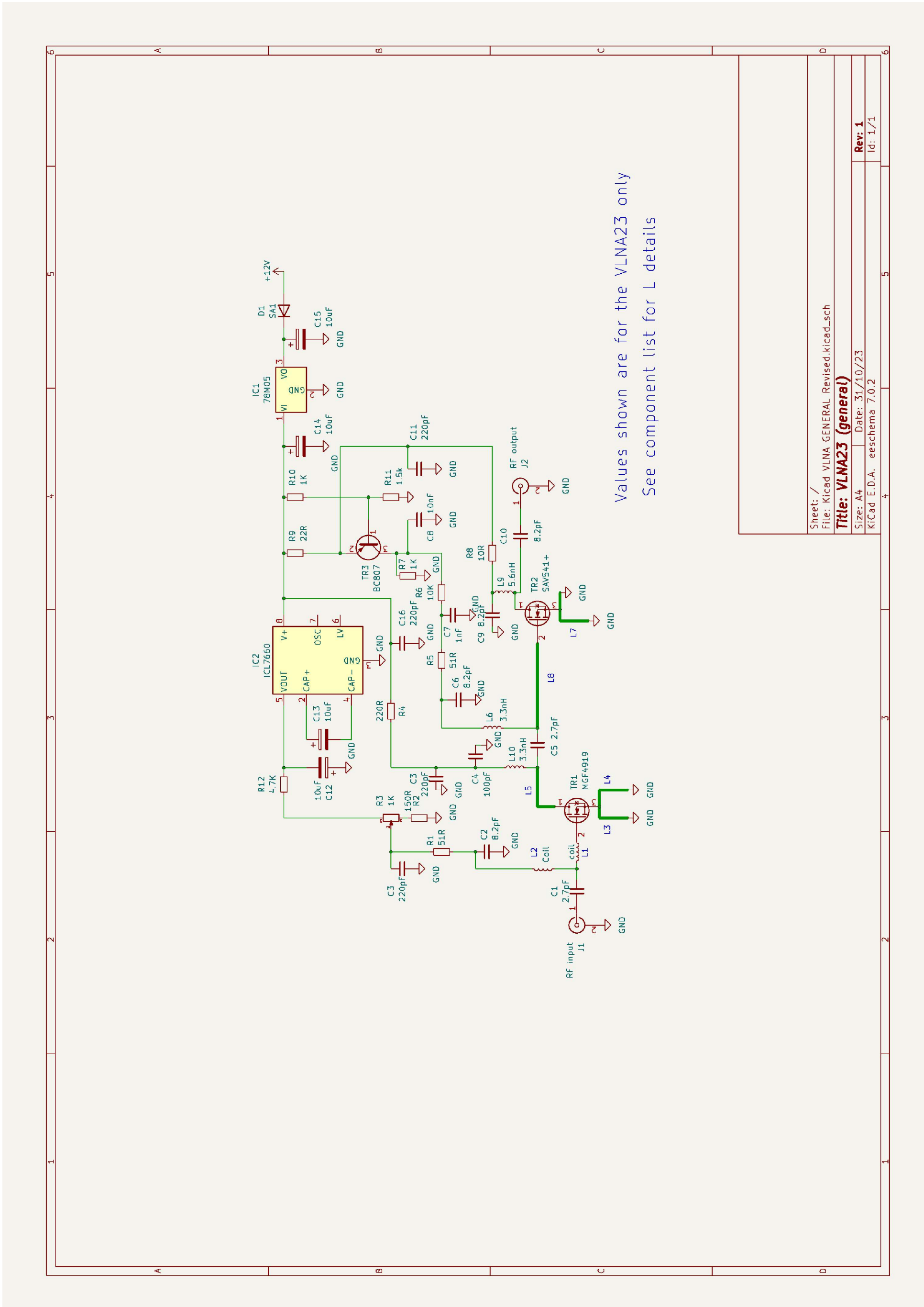
So, what of the future availability of the VLNA preamps?

The VLNA23 was originally designed to be used as an EME preamp with high gain to overcome second stage contributions from cable and bias tee etc. It was quickly found that the VLNA also functioned well at 13cm, even though that was not the original plan. Use on 70cm and 9cm was also found possible.

The following schematic shows the 23cm circuit values. A few of these require changing as shown in the original **www.g4ddk.com/Products.htm VLNA23** **information on my web page. [2]**

Further changes to values may be made as experience is gained in building and testing VLNAs for other frequency ranges. These may be published when available.

Schematic of the revised VLNA C



<u>Table 1</u> Component details for the VLNA23 (C PCB)

Table 2 shows the values for the other variants

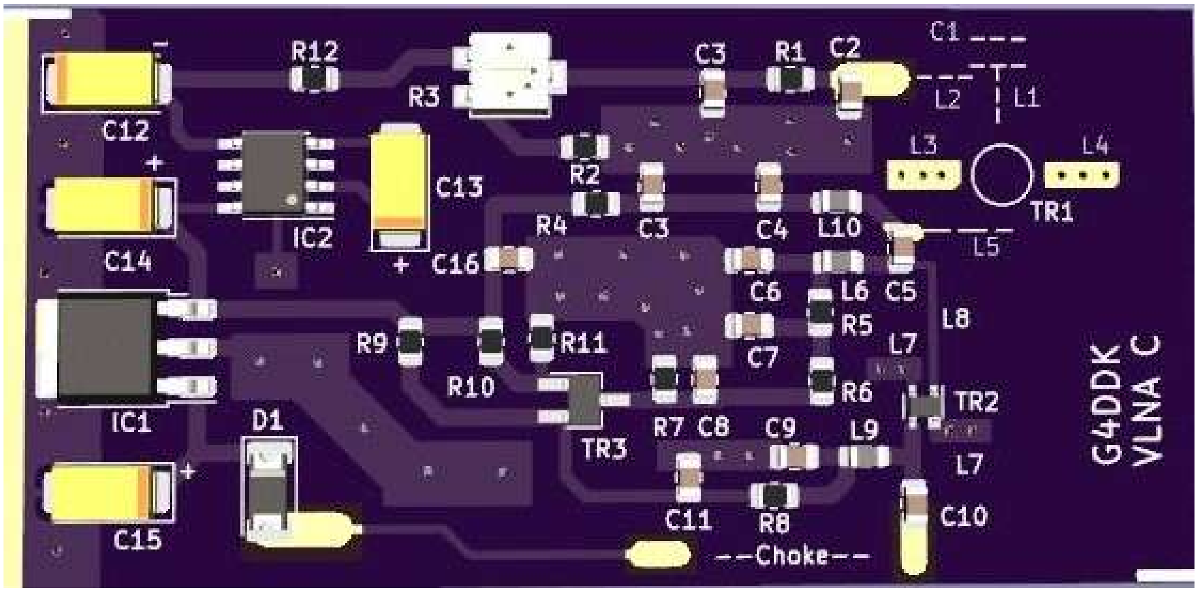
VLNA C 23cm BOM

Designation	Value	Rating	Size	Supplier
TR1	MGF4919			www.TVSAT.
TR2	SAV541+			Mouser, Min
TR3	BC807		SOT23	Various
IC1	78M05	5V/500mA	Mini DPAK	Various
IC2	ICL7660		SOIC8	Various
D1	S1A	1A	SMD	Various
C1	See table	Low ESR type	SMD 0805	
C5	2.7pF	Ceramic ML		
C2, C6, C9, C10	8.2pF	Ceramic ML	SMD 0805	
C3a, C3b, C11, C16,	220pF	Ceramic ML	SMD 0805	
C4	100pF	Ceramic ML	SMD 0805	
C7	1000pF	Ceramic ML	SMD 0805	
C8	10000pF	Ceramic ML	SMD 0805	
C12, C13, C14, C15	10uF Tantalum	25V	SMD 2312	Various
C17	1000pF	Solder-in feedthrough	2.5 -3.0mm	Eisch Kafka-
R1, R5	51R		SMD 0805	Various
R2	150R		SMD 0805	Various
R3	1k	Bourns 3314G-1-102E	5mm	Farnell Elect
R4	220R		SMD 0805	Various
R6	10k		SMD 0805	Various
R7, R10	1k		SMD 0805	Various
R8	10R		SMD 0805	Various
R9	22R		SMD 0805	Various
R11	1.5k		SMD 0805	Various
R12	4.7k		SMD 0805	Various
L1	3.75 turns, 2.5mm inside diameter	Enamel covered copper wire	0.312mm	See table 2
L2	1.5turns, 2.5mm inside diameter	Enamel covered copper wire	0.312mm	See table 2
L3, L4	8mm source wires	Enamel covered copper wire	0.312mm	See table 2
L5	See table 2	Enamel covered copper wire	0.312mm	See table 2
L6, L10	3.3nH	EPCOS	SMD 0603	Farnell Elect
L7		Printed on PCB		
L8		Printed on PCB		
L9	5.6nH	EPCOS	SMD 0603	Farnell Elect
J1, J2	SMA	2 or 4 Hole flange, gold plated		Various
Tinplate box		72mm x 37mm x 30mm		Eisch Kafka-
Absorber	Cavity resonance absorber 0.080"			MAST MR21-
	Note: self-adhesive absorber needed to secure the tile to the board and box			

Table 2 Component values for selected frequencies between 1296MHz and 2400MHz

Designation	**23cm/1296MHz**	**21cm /1420MHz**	**17cm/1700MHz**	**13cm/2200 -2400MHz**	**Size**	**Supplier**
C1	2.7pF	2.7pF	2.7pF	3.3pF	SMD 0805	ATC/AVX/Murata
C5	2.7pF	2.7pF	2.7pF	3.3pF	SMD 0805	ATC/AVX/Murata
C8	8.2pF	8.2pF	8.2pF	4.7pF	SMD 0805	ATC/AVX/Murata
L1	3.75 turns, 2.5mm ID, close wound	2.75 turns, 2.5mm ID, close wound	2.5turns, 2.5mm ID, close wound	16mm, single turn, 2.5mm ID	0.312mm enamel covered copper wire. solderable	
L2	2.5 turns, 2.5mm ID, close wound	2.5 turns, 2.5mm ID, close wound	2.5 turns, 2.5mm ID, close wound	1.5 turns, 2.5mm ID, close wound	0.312mm enamel covered copper wire. solderable	
L5	12mm length Between drain and C5	12mm length Between drain and C5	12mm length Between drain and C5	11mm length Between drain and C5	0.312mm enamel covered copper wire. solderable	

VLNA C PCB



Note: In this version there are two C3 220pF capacitors. The Schematic was later amended

A 10 turn wire choke can be soldere where shown to enable power feeding from the output coaxial connector cable.

Building a VLNA C preamp

This section should be read in conjunction with the original VLNA PDF 'A very low noise (pre)-amplifier for the UHF 70cm to 9cm bands' [2]

www.g4ddk.com/Products.htm

Construction of the VLNA C preamp is mechanically similar to the previous (green board) version, with the input and output SMA female connectors being soldered to the outside of the tinplate box. As the layout has changed slightly, the input connector is now located directly in line with the gate of TR1 FET. The output connector has its spill soldered directly to the putput track of the VLNA. Care must be taken to ensure that the spill is the correct height above the PCB. Following the green board VLNA assembly instructions should ensure the connector box 4mm hole is in the correct place (2.3mm above the line you marked inside the box to locate the lower edge of the PCB for seam soldering).

The feedthrough capacitor should be located just to the right of the line through D1 so that you have room to solder a link wire from the feedthrough to the large PCB land to the right of D1 anode end. If you try to bend the feedthrough capacitor lead down, to touch the pad, you risk the capacitor cracking. Use a wire link to prevent this happening.

SMD inductors L6, 9 and 10 are all EPCOS (Farnell Electronics) low Q 0603 size to ensure self resonance is well above the 13cm band.

Now, very important.

This preamplifier requires 80 thou RF Absorber to inhibit any tendency for the first stage to self oscillate, due the use of source feedback.

The type of absorber should be around 80 thou thick, polyurethane based, such as that from Mast or ARC. It is preferable to use the self adhesive type as polyurethane reacts with the common adhesives such as Bostic, Evostick and superglues.

The type of adhesive that works well is silicon based, such as DOW345.

A piece of absorber tile, 30mm x 40mm, is required although slightly shorter is usually OK. This is stuck inside the lid such that it is over the TR1 and TR2 locations. A smaller strip, about 3mm wide and 15-20mm long should be stuck to the PCB parallel to L8 and about 1-2 mm from L8.

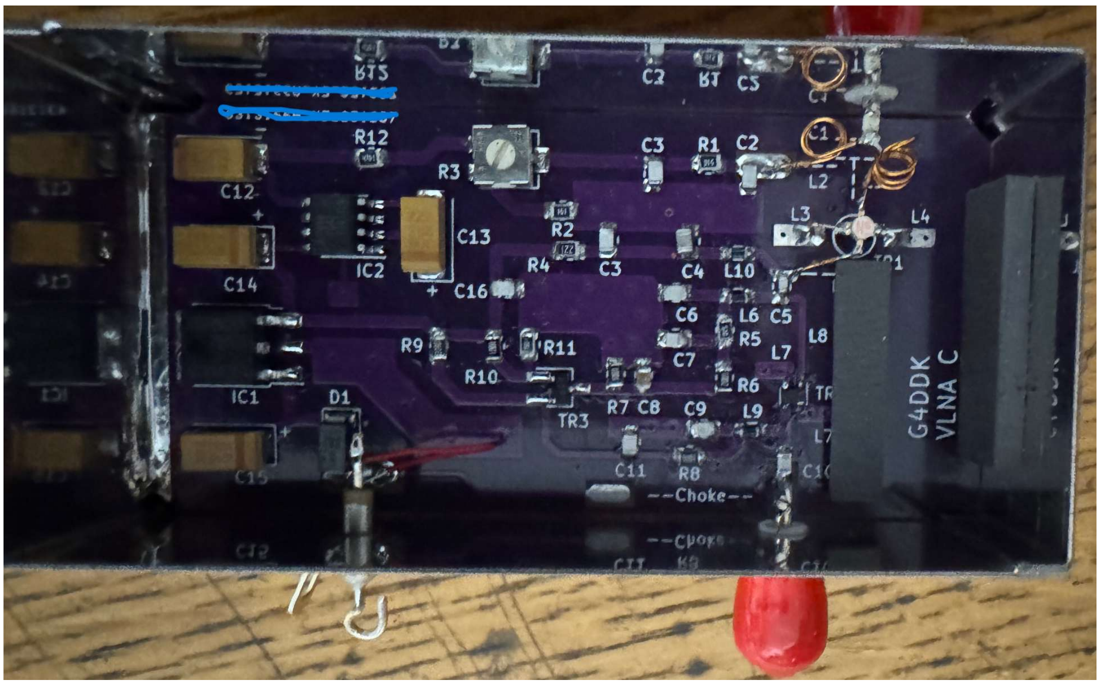


Photo 1

A built VLNA23 (C) showing the position of the absorber adjacent to L8. The piece on the end wall is no longer required or recommended.

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Alignment

Apply +12v to +20V (no higher) and check for +5V output from IC1 voltage regulator. Check between the positive end of C14 and the box

If OK, then check for -5V output from IC2 at the negative end of C12.

Check for +2.95 to +3.0V at the junction of R8 and C9. The current through R8 will be 64/65mA measured as 0.65V across R8 (10R).

- If this is 5V then it indicates TR2 is not taking current.

Check for +0.54V approx. at the junction of L6 and C6

If these voltages are wrong, there is a problem; most likely with the soldered connections to TR3 (from experience).

If these voltages are OK then proceed to check TR1.

Measure TR1 drain current as a voltage drop across R4. Adjust R3 so that the voltage across R4 reads 2.86V, corresponding to 13mA through the resistor. This may be later adjusted to between 10mA and 15mA to achieve the lowest noise figure.

- A reading of 5V at the drain of TR1 indicates that TR1 is not drawing any current. This may be due to the FET being open circuit source to drain.

On the other-hand 0v, or near 0V, indicates it is drawing a lot of current, possibly due to no gate bias. This should be around -0.12V but may be a bit outside this range. Alternatively, TR1 may be open gate due to static or RF damage.

When the voltages/current are correct you can SLIGHTLY adjust R3 and/or L1 for best noise figure, if you have access to a suitable noise source and noise indicator. The usual position for R3 is slightly up from fully anticlockwise.

If you don't have these then you will need to accept the noise figure and gain you have achieved already.

The achievable noise figure at 1296MHz is 0.25dB with an insertion gain of 35-37dB.

The equivalent figures at 2320MHz are below 0.3dB noise figure but lower insertion gain at around 27-28dB

These figures may be amended after some further development work.

References

1. An updated VLNA for the 23cm and 13cm Amateur Bands, G4DDK. Proceedings of the Microwave Update 2024, October 3-5 2024, Vancouver British Columbia, Canada.
2. www.g4ddk.com

Document History

Original – Microwave Update 2024	1 August 2024
Revision 1	26 November 2024
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