JUMA 100W PA – Main Board

Greg Mew – VK4GRM

Contents

Purpose

This is the second document in this series that describes the build and testing of the JUMA PA100-D in a step by step process with thoughts and ideas based on my build of the 100W PA. Most of the graphics are from the JUMA website[1] and are placed in the order of the build as it progressed. Other photographs are those taken by myself during the build of the PA100-D.

This document aggregates the information provided on the JUMA website into a single document with additional commentary by myself. Thanks also to Ed (WA4MZS) for review comments which have been included.

Each section of the document provides the schematic diagram, the PCB layout, parts list and then the installation instructions. Testing of the PA100-D is in the latter part of the document.

Main Board Module

General

The Main Board handles T/R switching, RF gain, low-pass filtering, FWD/REV power sensing and current sensing. The Main Board is wired to the control module and to the RF amplifier module with flat ribbon cables. There is also a pin header connector (J3) for the F-sense module which is used in PA100-D digital model. Refer to Figure 1 and Figure 2 for the schematic diagrams of the Main Board.

Transmit/Receive control

There are two methods used for the T/R switching (PTT control). In the case of the JUMA exciters, the T/R switching is fed via the RF coaxial cable as DC current from exciter to the PA100. Thus no extra PTT cable is needed with JUMA exciters. In case of other exciters a PTT cable is needed between an exciter and the PA100. It is a grounding signal (open collector, open drain or relay signal) to the tip of the KEY IN/OUT jack socket J2. The required sink current is less than 2 mA. TR1 handles this KEY IN detection. The final T/R switching signal (KEY => +TX) is routed via the control board which controls the T/R relay RL1 by means of the MOSFET TR3.

The exciter RF is passed directly to the ANT connector in the STBY state. During transmit the RF is fed to the input of the PA100 amplifier and the amplifier output is connected to the ANT connector.

Input attenuator

The relays RL2 and RL3 and the related resistors form a RF input attenuator. This allows operation with various exciter power levels (3W to 10W). There are four selectable gain levels in 2 dB steps.

Low-pass filters

There are 6 low-pass filter blocks on the board which will attenuate the harmonics. The filters are switched with the relays R4 to R9 by means of the relay driver IC2. Each lower band (1.8/3.5/7/10 MHz) is using its own low-pass filter and the upper bands have one filter block for 14/18 MHz and another for 21/24/28 MHz. The RF coils are constructed using iron powder toroidal cores. See winding instructions.

Current sense

IC1 is a high side current sensing circuit. The circuit is sensing the differential voltage across the 0.005 ohm shunt resistor R7 in the RF amplifier module. The circuit provides current dependent

[1] http://www.jumaradio.com/juma-pa100/

voltage of 0.1V/A for the control board. The current sensing circuit also includes a latching type over current detector. The over current level (default 24 A) is set with the resistors R19 and R20. The current signal value and over current state is handled by the control board.

Forward and reverse power sensing (SWR bridge)

The toroidal transformers T1 and T2 are measuring RF voltage and RF current. The transformers are combined for relative forward and relative reverse outputs. These signals are rectified with the diodes D11 and D12 and fed to the control module.

There are no adjustments in the main board.

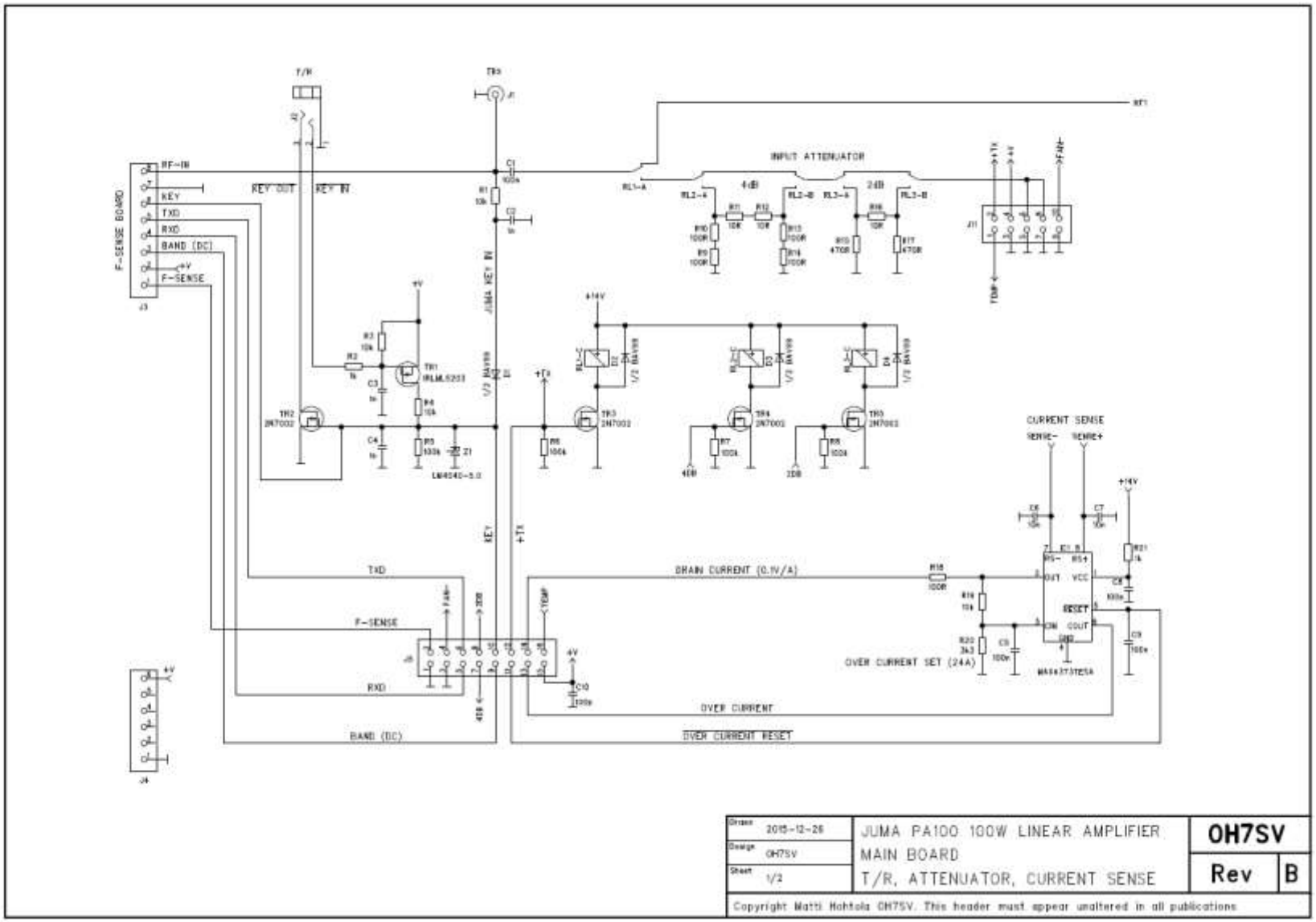


Figure 1 Schematic Diagram – Main Board – T/R Attenuator and Current Sense.

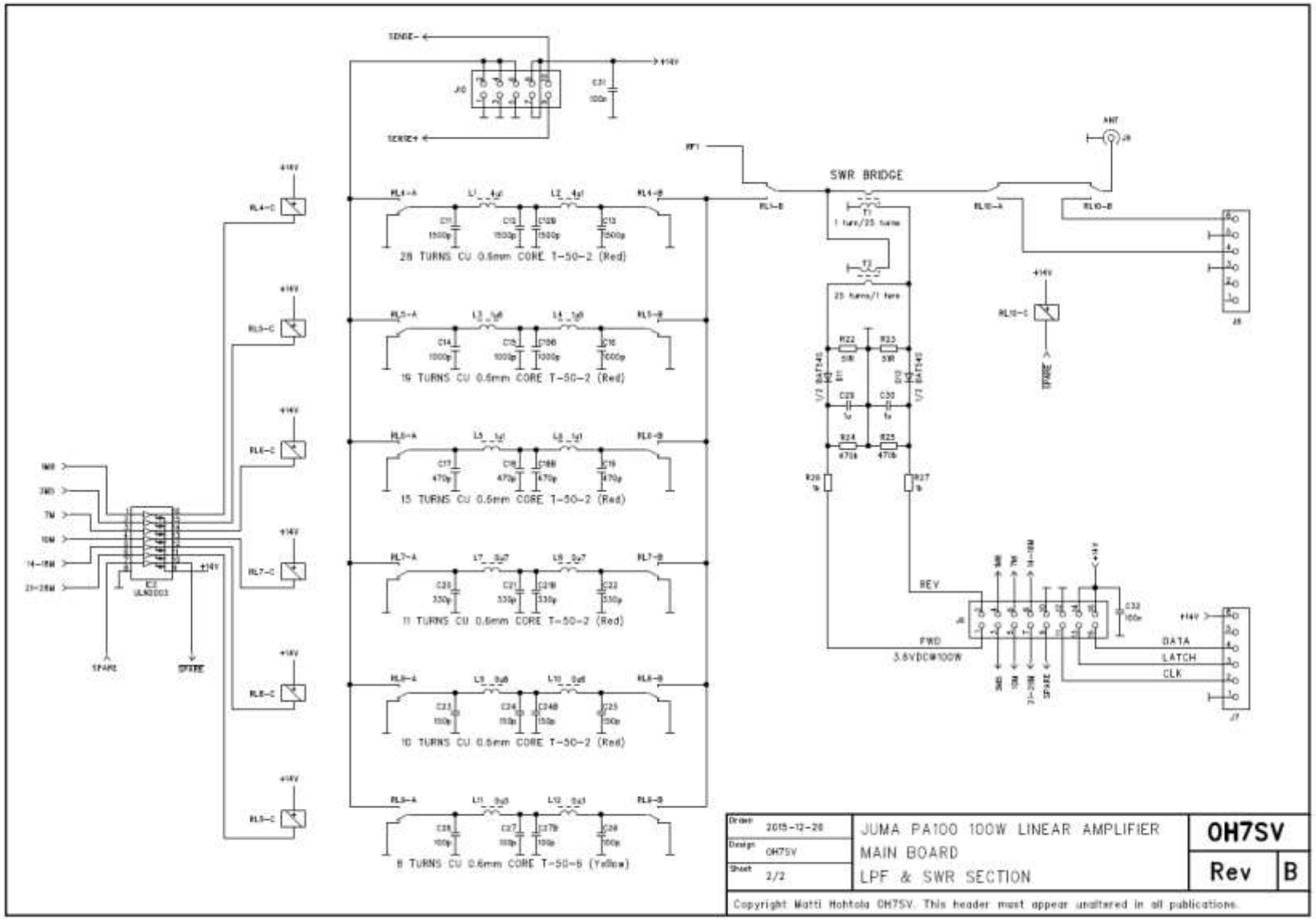


Figure 2 Schematic Diagram – Main Board – LPF & SWR.

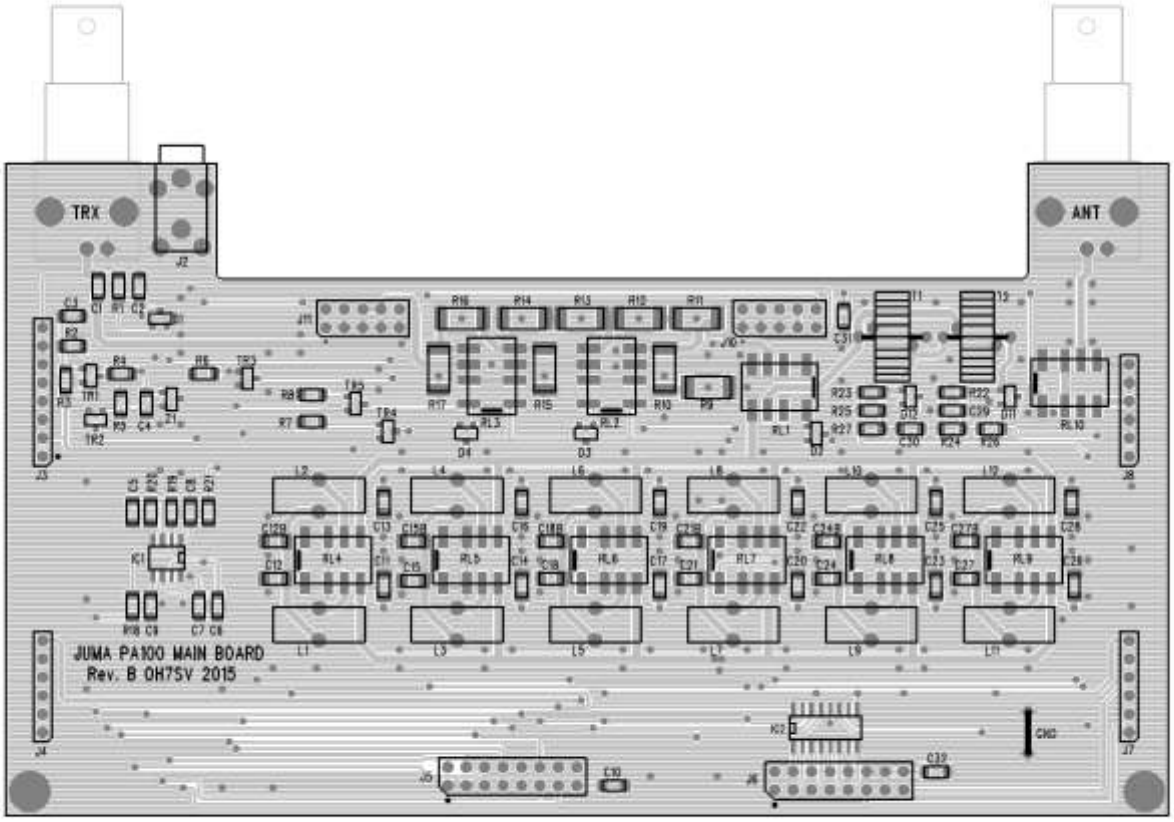


Figure 3 Main Board PCB layout

Figure 3 shows the diagrammatic component layout on the Main Board and Figure 4 and Figure 5 show the top and bottom views of the board.

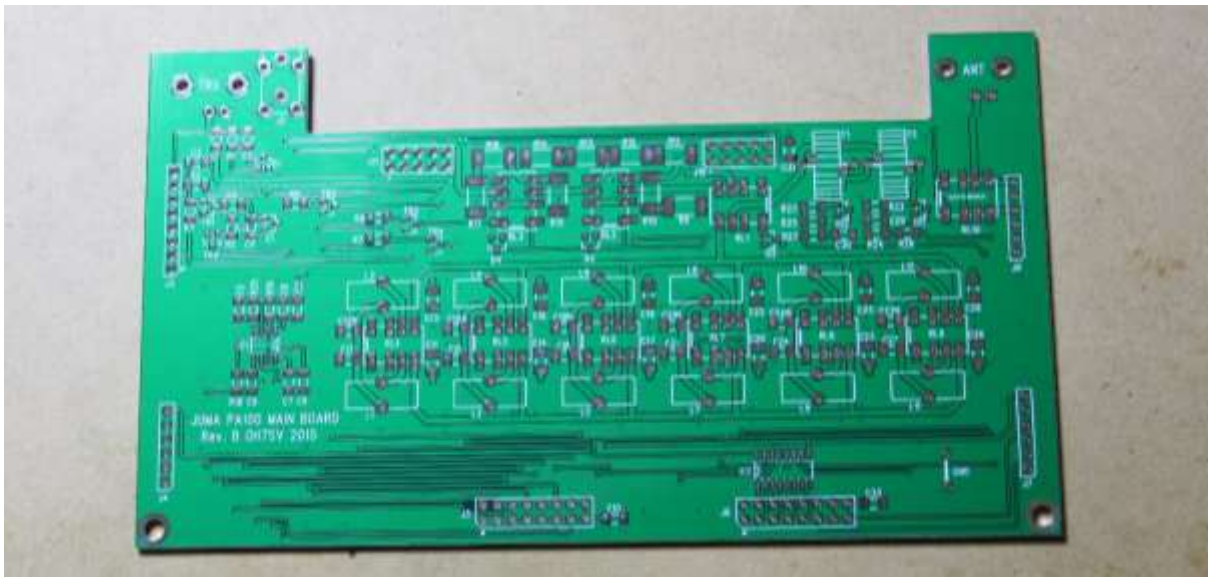


Figure 4 Main Printed Circuit Board

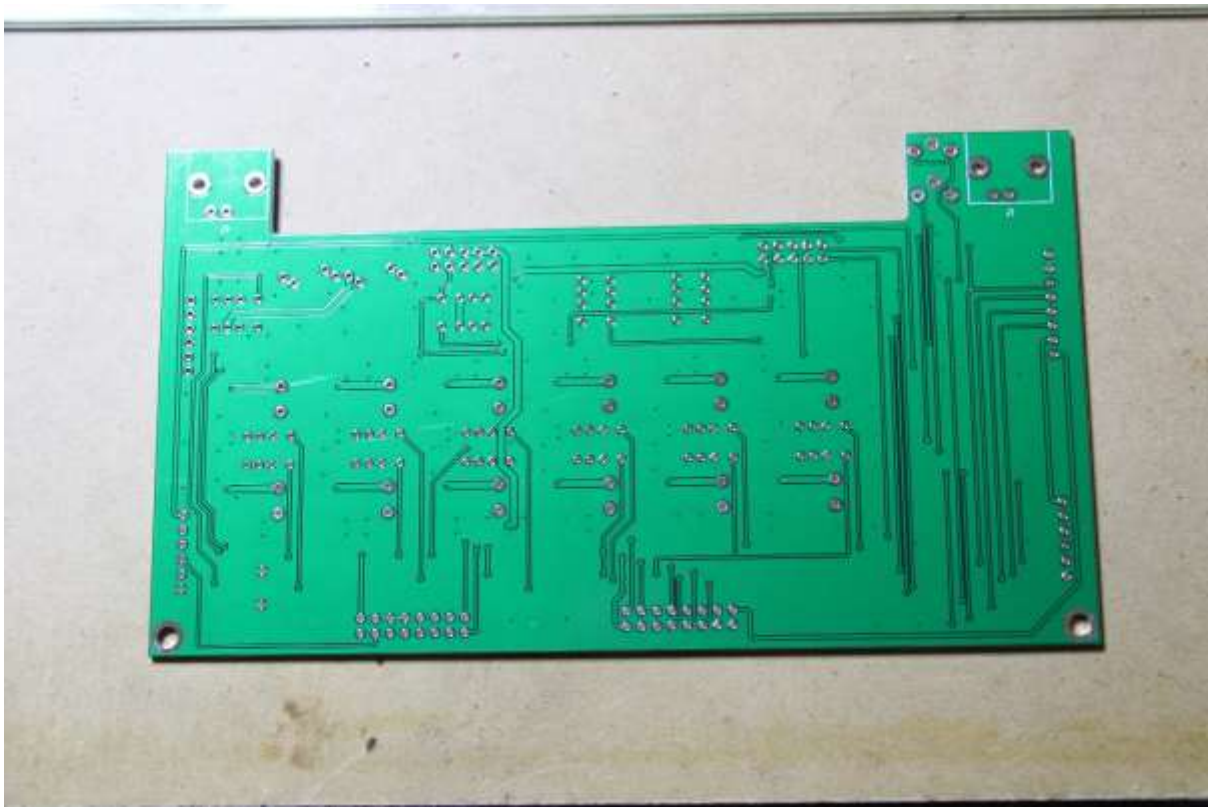


Figure 5 Main Printed Circuit Board – Rear View

The individual packs of components making up the Main Board module are shown in Figure 6 and Figure 7. There are five bags each labelled X of 5.

Figure 6 Main Board Component Bags

Figure 7 Main Board Component Bags – inverted

Parts List and Assembly instructions

The parts list is again provided as an Excel spreadsheet and a reminder here is that this list also provides the order of installation of the parts. The components should be assembled in the order shown in the spreadsheet. The lists shown for each of the component types in the following sections follow the order provided in the Excel spreadsheet.

I find it useful to tick off each component as it is soldered into the board so that you know exactly where you are up to. Further it is useful to sort out the components on removal from the bag and to place them in the order that they will soldered onto the board. For all resistors I measured the value using a multimeter to confirm that it is the correct component value.

Resistors

The resistors for the Main board are listed in Table 1.

Table 1 Main Board - Resistors

JUMA PA100 main board part list for PCB Rev. B, 2015-12-26 (install in this order)

Part number	Value / type	Qty	Description	Picture
JUMA PA100 main PCB	Rev B	1	PCB	
R22 R23	51R	2	SMD resistor size 1206 1%	
R18	100R	1		
R2 R21 R26 R27	1k	4		
R20	3k3	1		
R1 R3 R4 R19	10k	4		
R5 R6 R7 R8	100k	4		
R24 R25	470k	2		
R11 R12 R16	10R	3	SMD resistor size 2512	
R9 R10 R13 R14	100R	4	tolerance 1% or 5%	
R15 R17	470R	2	1W or 1.5W	

Resistors in the order indicated in Table 1. They are all shown fitted in Figure 8

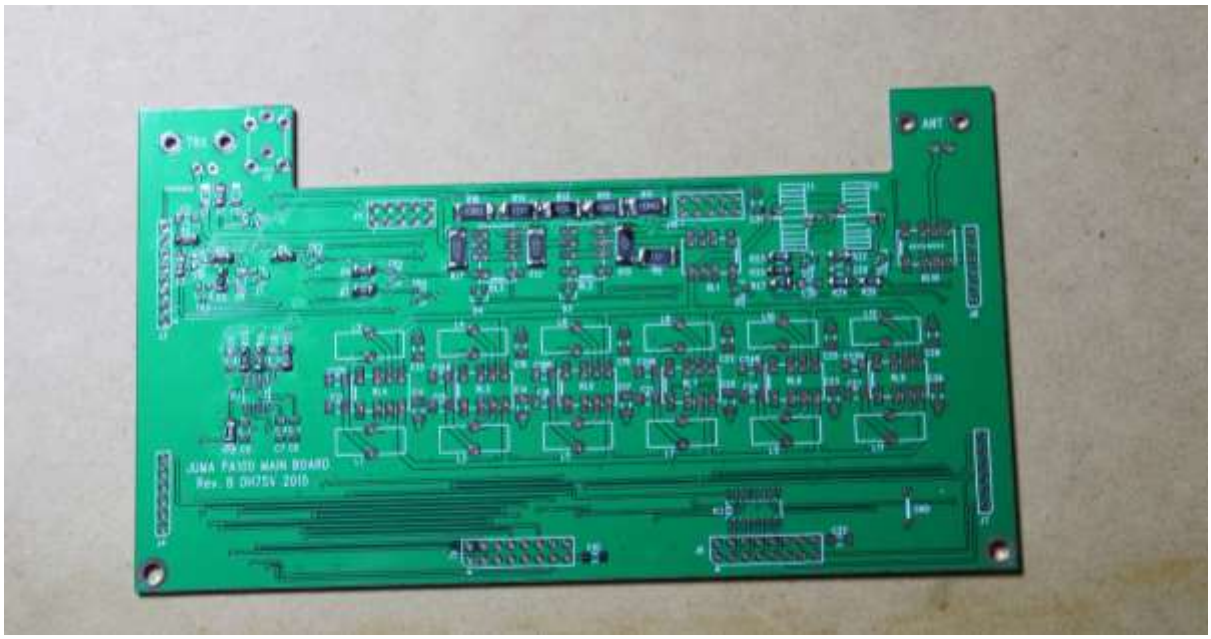


Figure 8 VK4GRM - Main Board with all Resistors Fitted

Capacitors

The capacitors for the Main Board are listed in Table 2 and the colour codes shown in Figure 9 to help identify them. Install in the order shown. I set them out as you see in Figure 9 and this helps to keep you on track with which ones you are fitting.

Note that the instruction sheet that comes in the bag with the capacitors has the colour coding identified as shown in Figure 10.

Table 2 Main Board - Capacitors

Part number	Value / type	Qty	Description	Picture
C2 C3 C4	1n	3	Ceramic capacitor size 1206 X7R	
C6 C7	10n	2		
C1 C5 C8 C9 C10 C31 C32	100n	7		
C29 C30	1u	2		
C26 C27 C27B C28	100pF AVX12062A101J	4	Size 1206 C0G/200V or similar RF specified	
C23 C24 C24B C25	150pF AVX12062A151J	4		
C20 C21 C21B C22	330pF AVX12062A331J	4		
C17 C18 C18B C19	470pF AVX12062A471J	4		
C14 C15 C15B C16	1000pF AVX12062A102J	4		
C11 C12 C12B C13	1500pF AVX12062A152J	4		

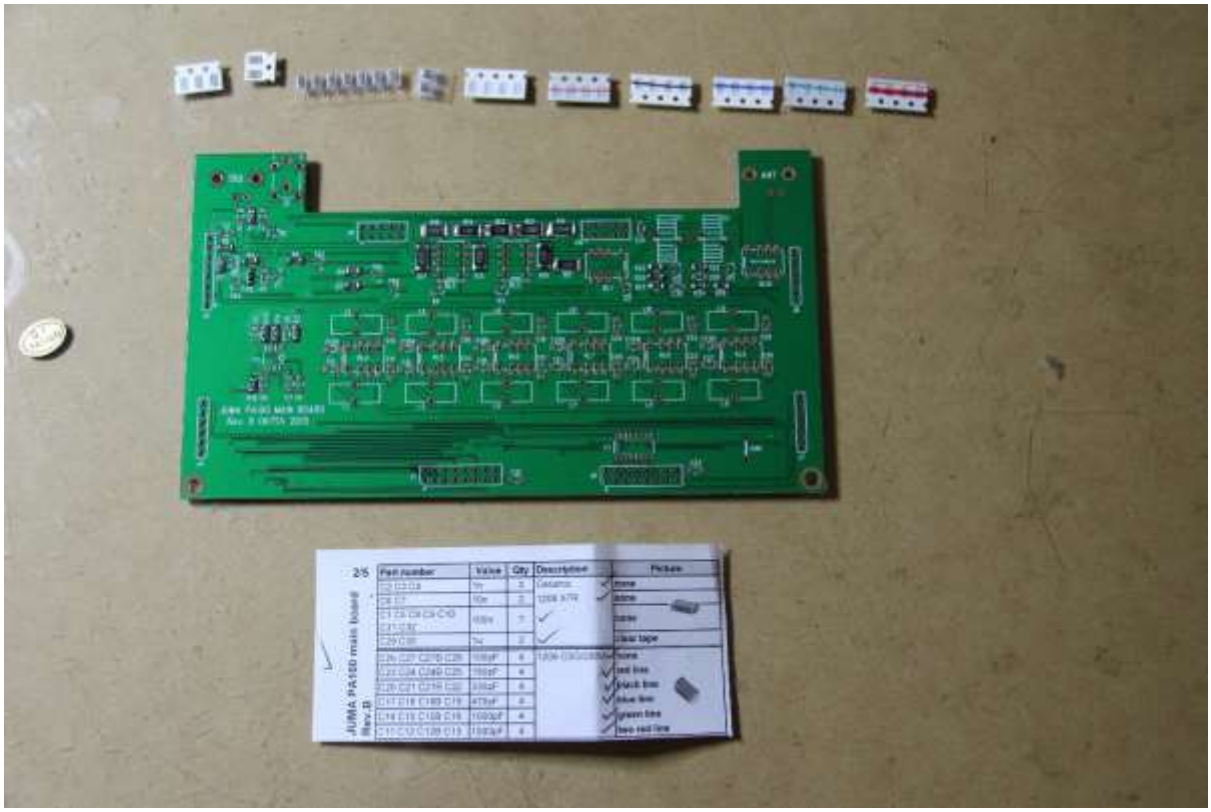
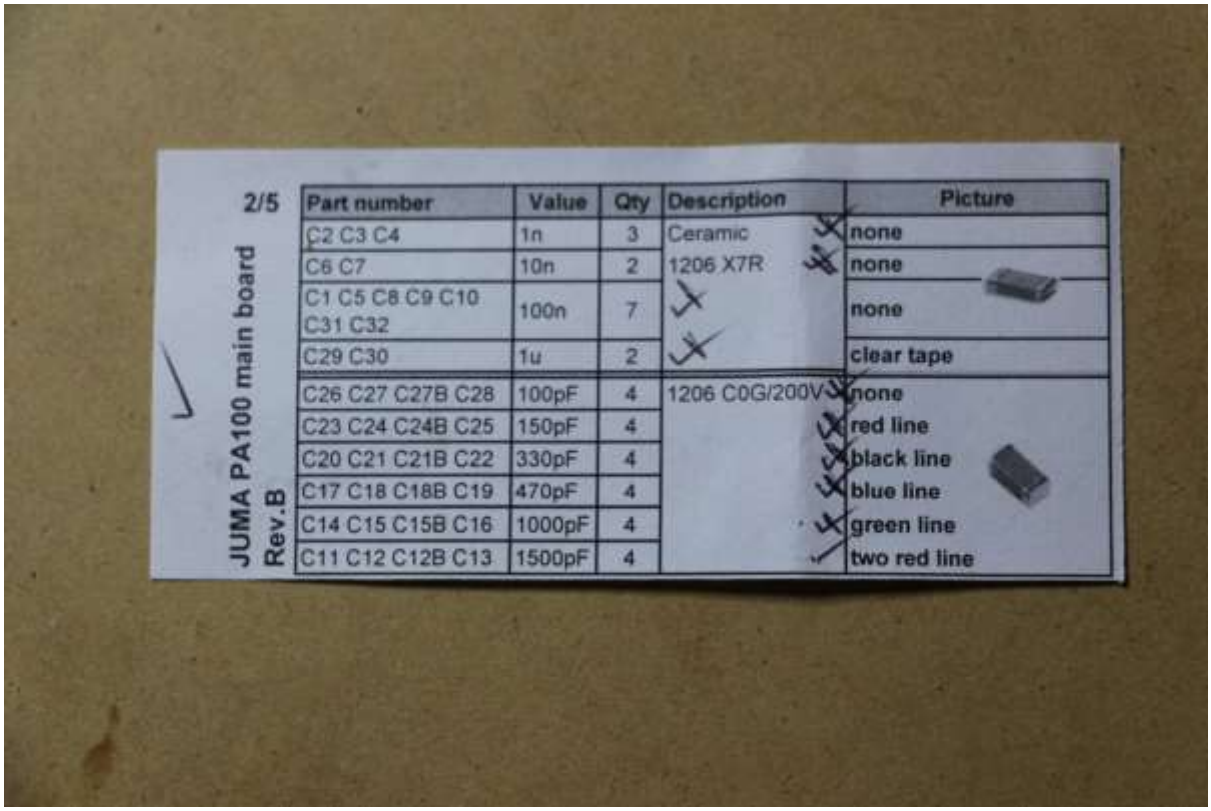


Figure 9 VK4GRM - Main Board with capacitors with their colour coding showing before assembly.



2/5

JUMA PA100 main board Rev.B

Part number	Value	Qty	Description	Picture
C2 C3 C4	1n	3	Ceramic	none
C6 C7	10n	2	1206 X7R	none
C1 C5 C8 C9 C10 C31 C32	100n	7		none
C29 C30	1u	2		clear tape
C26 C27 C27B C28	100pF	4	1206 C0G/200V	none
C23 C24 C24B C25	150pF	4		red line
C20 C21 C21B C22	330pF	4		black line
C17 C18 C18B C19	470pF	4		blue line
C14 C15 C15B C16	1000pF	4		green line
C11 C12 C12B C13	1500pF	4		two red line

Figure 10 VK4GRM - Capacitor colour coding on the note sheet provided with the components.

The Main Board with the resistors and capacitors fitted is shown in Figure 11.

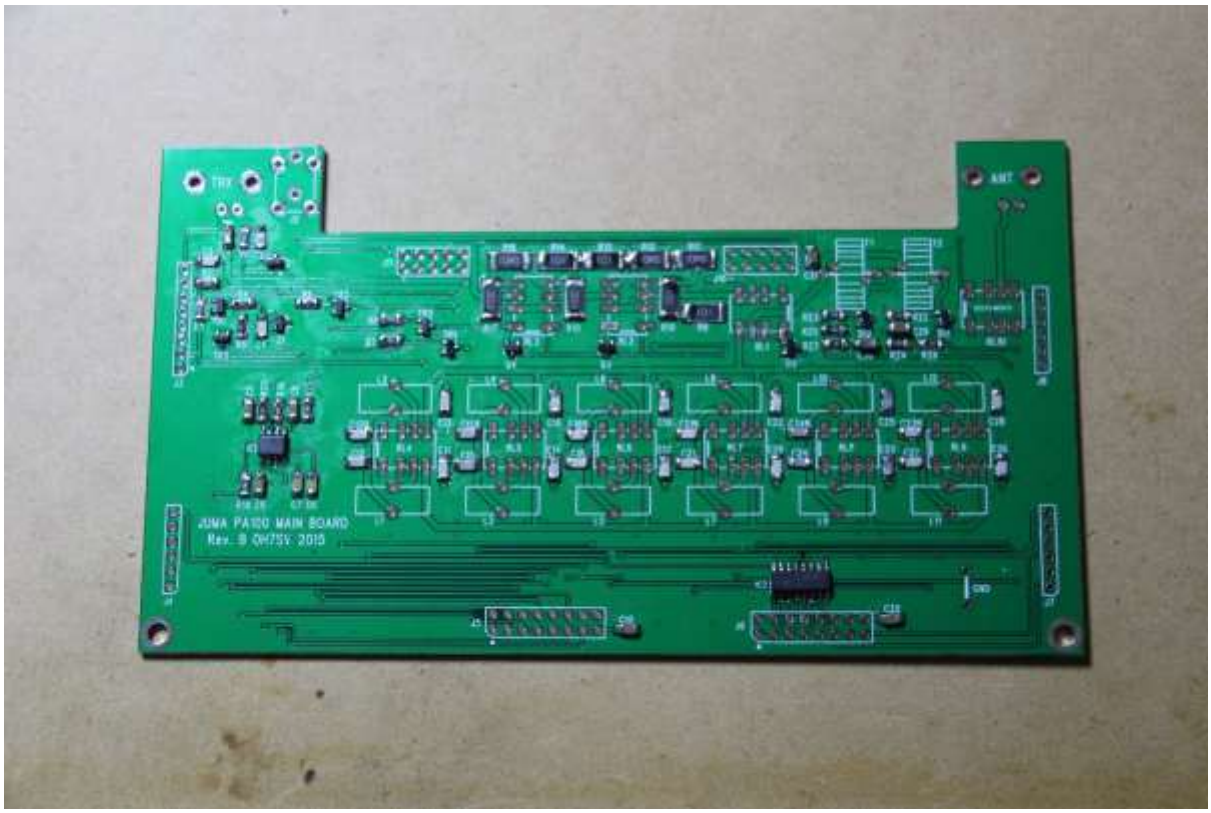


Figure 11 VK4GRM – Main board with Resistors, Capacitors and ICs fitted.

Semiconductor Devices

The semiconductor devices for the Main Board are listed in Table 3 and shown installed in Figure 11 and Figure 12.

Table 3 Main Board – Semiconductor Devices

Part number	Value / type	Qty	Description	Picture
D1 D2 D3 D4	BAV99	4	Dual Si-diode SO23	
D11 D12	BAT54S	2	Dual schotky diode SOT23	
Z1	LM4040-5.0	1	Voltage Ref 5V SOT23	
TR1	IRLML5203 or BSS84	1	MOSFET P-type SOT23	
TR2 TR3 TR4 TR5	2N7002	4	MOSFET N-type SOT23	
IC1	MAX4373TESA	1	Current sense IC case SO8	
IC2	ULN2003	1	Relay driver case SO16	

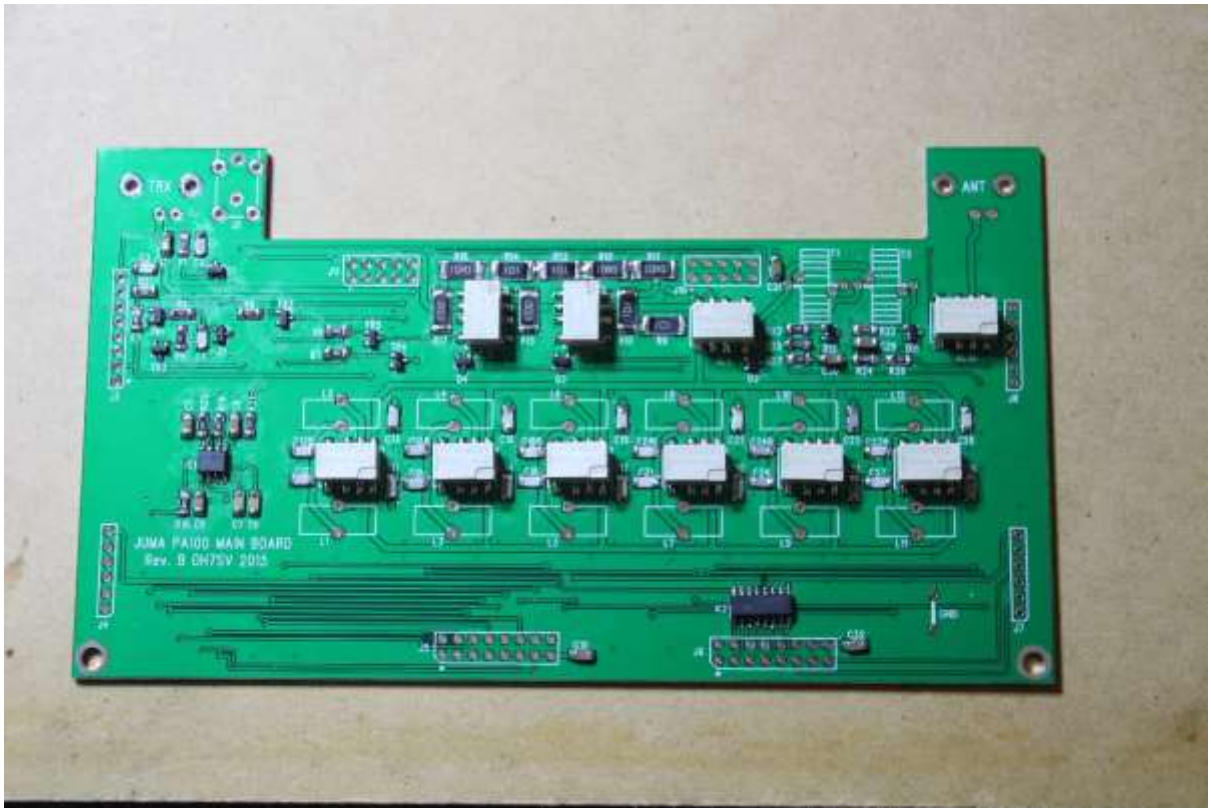


Figure 12 VK4GRM – Main Board with Semiconductors and Relays fitted.

Relays and Inductors

The relays and inductors for the Main Board are listed in Table 3 and the winding instructions for the inductors are shown in Figure 13. The transformer winding instructions are shown in Figure 14.

Table 4 Main Board – Relays and Inductors

Part number	Value / type	Qty	Description	Picture
RL1 RL2 RL3 RL4 RL5 RL6 RL7 RL8 RL9 RL10	Axicom IM06TS Newark part number 25M9784	10	PCB relay. Also SMD type IM06GR can be used Newark Part Number 19K8742	
L1 L2 L3 L4 L5 L6 L7 L8 L9 L10	Amidon T-50-2 iron powder toroidal core (color red)	10	28, 19, 15, 11, and 10 turns See the winding instructions	
L11 L12	Amidon T-50-6 iron powder toroidal core (color yellow)	2	8 turns See the winding instructions	
Enamel copper wire	Diameter 0.6 mm (or AWG 22) Len 25 mm per turn	1	5 meters of copper wire for toroidal inductors L1-L12	
T1 T2	Amidon FT-50-61 ferrite toroidal core	2	25 turns See the winding instructions	
Enamel copper wire	Diameter 0.4 mm (or AWG 26) Len abt 35 mm per turn	1	2 meters of copper wire for transformers T1 and T2	
Tinned copper wire	Diameter 0.8 mm, length 10 cm		For SWR transformer and for the GND jumper	

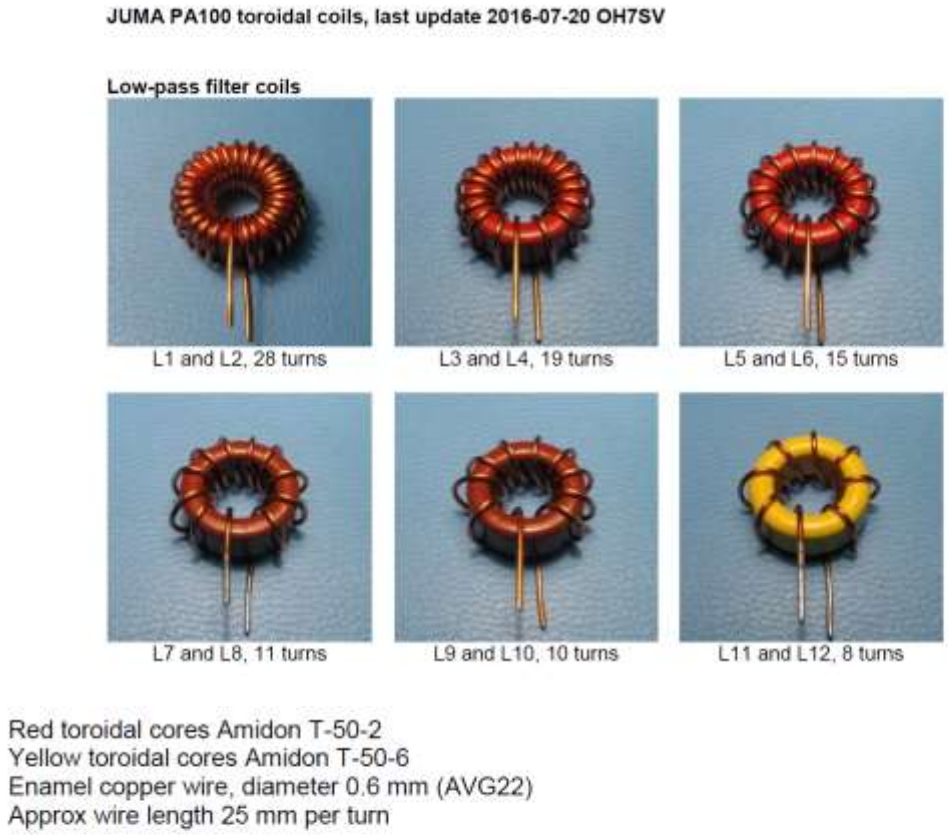


Figure 13 Inductor Winding Instructions.

SWR transformer coils

T1 and T2, 25 turns

Amidon toroidal core (color black) FT-37-61 in Rev A and FT-50-61 in Rev B
Enamel copper wire, diameter 0.4 mm (AVG26)
Approx wire length 25 mm per turn

Add one turn of tinned copper through the core when installing the SWR coils on the board. See pictures.

Figure 14 Transformer Winding Instructions.

Note that there is plenty of wire supplied to wind each of the inductors or transformers, provided that you use the 25mm per turn figure. I used a little less than that without problems. Take care with winding the coils and transformers and keep the turns as tight as possible to stop them moving once the board is assembled. Leave the leads long so you can pull then tight when you solder them.

Other Hardware

The other hardware for the Main Board is listed in Table 5 and the completed board is shown in Figure 15

Table 5 Main Board – Other Hardware

Part number	Value / type	Qty	Description	Picture
J3	Socket 1 x 8 for pin header	1	Snippet of Fischer BL5.36Z Farnell 9728910	
J4 J7 J8	Pin header 1 x 6 2.54 mm pitch, pin max 6.7 mm	0	**Not installed**	
J5 J6	Pin header 2 x 8 2.54 mm pitch, pin max 6.7 mm	2	Snippet of e.g. Tyco Electronics 5-826632-0 or MOLEX 90131-0775	
J10 J11	Pin header 2 x 5 2.54 mm pitch, pin max 6.7 mm	2		
J2	Jack socket 3.5 mm, 3 pole Marushin MX-387GL Newark part number 24M5044	1	PTT in/out connector	
J1 J9	BNC coaxial socket, MULTICOMP 13-60-3 **low profile** Same manufacturer code number for normal and low profile type! **Low profile** text must be included. Newark/Farnell part 1169557	2	Align with the rear panel	
Plug	3.5 mm stereo	1	For T/R input (PTT in)	

The Main Board with inductors and transformers fitted is shown in Figure 15.

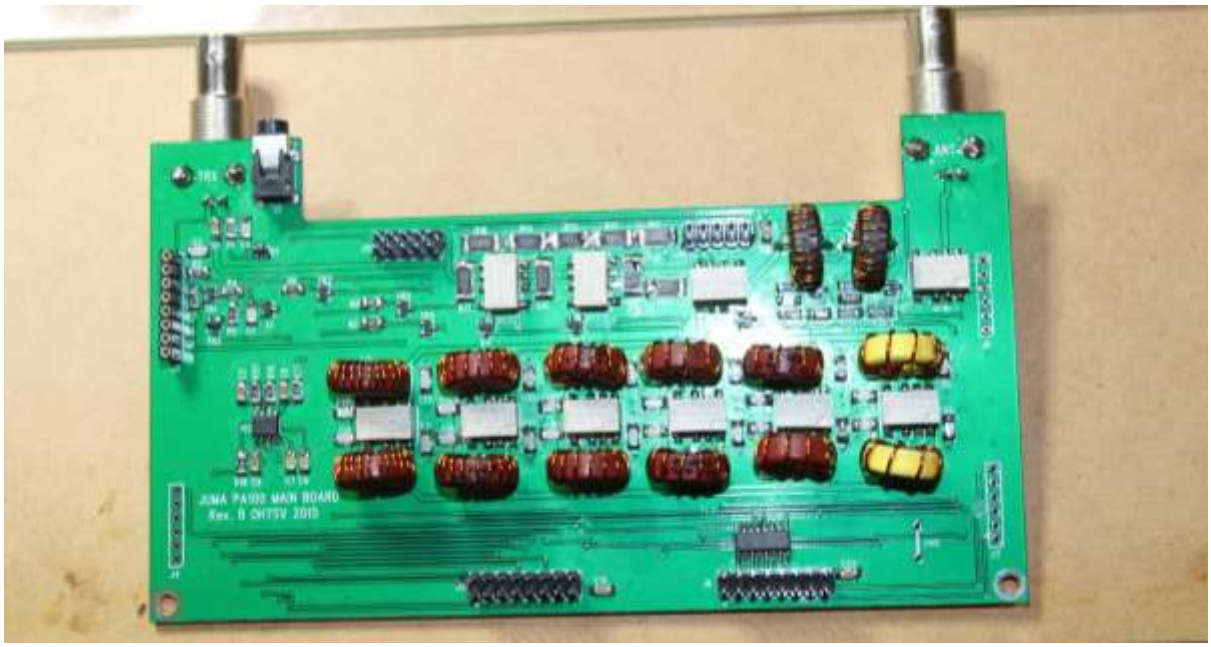


Figure 15 VK4GRM – Main Board with Semiconductors, Relays Inductors and Transformers fitted.

NOTE make sure that you fit the BNC Connectors to the correct side of the board – the bottom side. They are very hard to remove once installed. I found out the hard way.

Also don't forget to solder the earth link (labelled GND) shown on the board near J7.

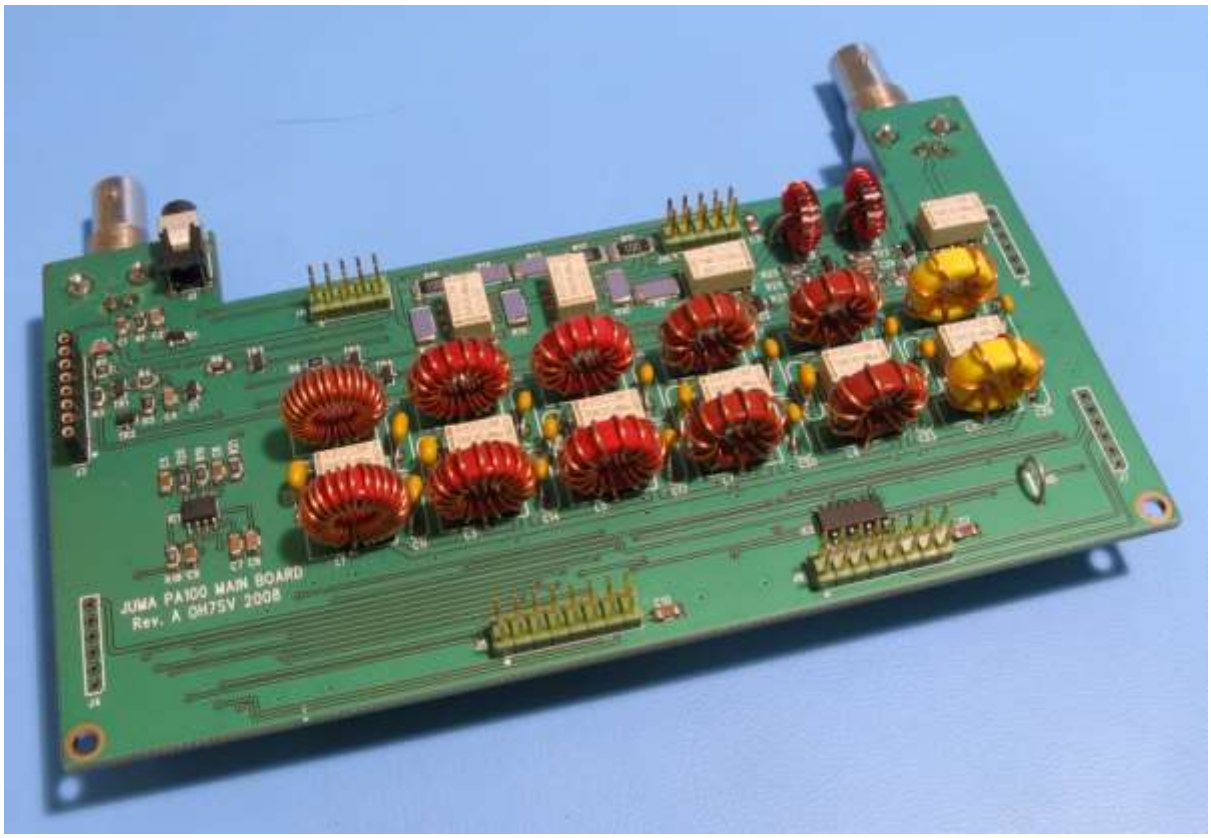


Figure 16 Completed Main Board.

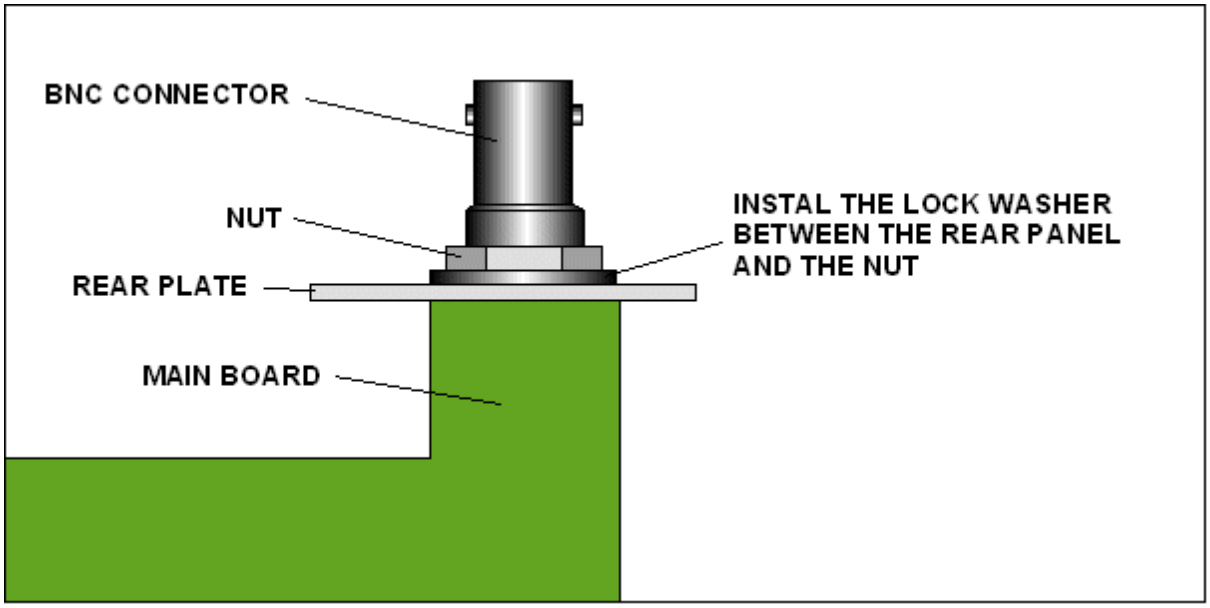


Figure 17 Completed Main Board.

Testing

There are no setups required on the Main Board however it is recommended that you check for shorts between the +14VDC rail and the 0V rail. This can be done between Pin 6 and Pin 1 of J7. Pin 6 is the +14VDC rail as shown in Figure 2.

If you find a short circuit you will need to look for any solder bridges by following the +14VDC rail on the PCB layout and checking any components that go from the rail to ground. Check that IC2 does not have a solder bridge.