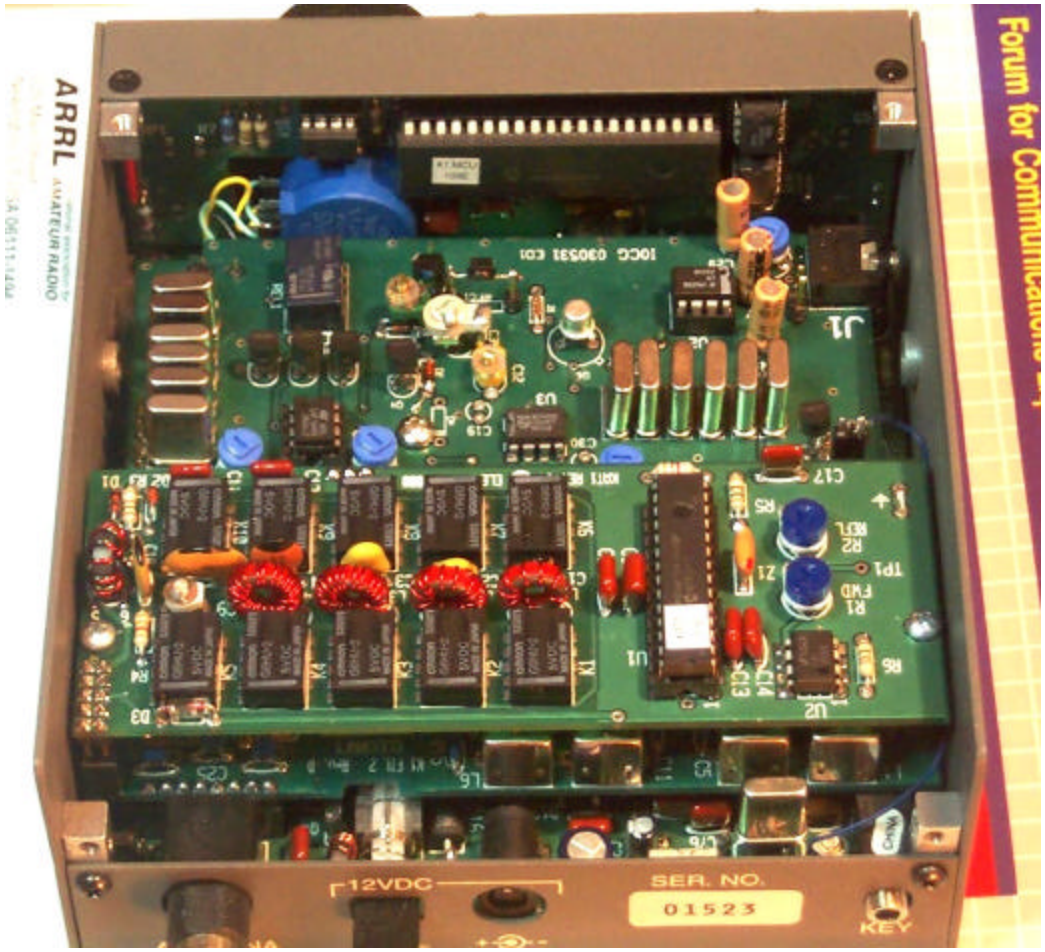
K1 SSB Modification (Ed.2)

This description provides the receiver (RX) modifications, assembly, alignment and operation as a first step. In a second step you can add the remaining transmitter (TX) modifications, assembly and alignment. Then you have converted your K1 into a QRP CW / SSB transceiver.



Beta-test ED1 PCB installed in I0CG's K1

RX Part **Assembly**

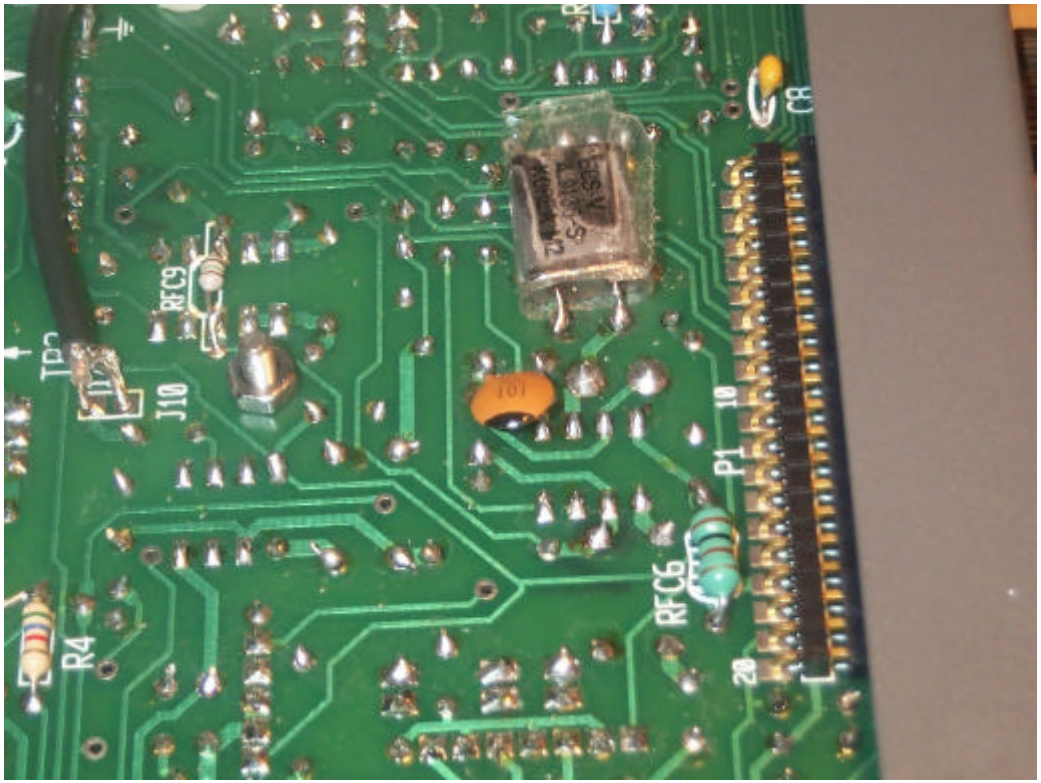
K1 RF Board RX Modifications

Remove the following components:

R21, C38, RFC1
R21 is only suitable for CW (cut off of frequencies higher than 1 kHz). R21 is removed in order to obtain a flat audio response for SSB

Add the following components:
Insert a 4 pin (female) connector in place of C38 and RFC1. (See K1 RF Board Photo on page 10)
(To restore the normal K1 functionality you can fit C38 and RFC1 into this connector)
Insert a single pin (female) connector to made available the XFILT/TONE signal. This signal is located near the RF-P1 connector (X5).
Insert the Noise blanker connector J1 (8 pin female)
Insert a 68-pF NPO capacitor in parallel to C2 (120-pF), this will extend the K1 frequency range up to 250 kHz (e.g. 7-7250 or 14-14250)

Replace the following components:
Replace C63 with 100-pF (I suggest you to disconnect only one pin of C63 and put the new capacitor on the bottom side of the K1 RF PCB, so that restoring the original value becomes very easy).
Replace X6 with the supplied 4915 KHz crystal and connect the original X6 crystal in parallel to the existing X5 crystal.
I suggest you to put the crystal on the bottom side of the K1 RF PCB (isolate the crystal case to avoid undue short circuits).
This modification provides a better frequency control over the VXCO.
This technique (known as "Super VCXO") has been also used in Elecraft's K2 transceivers and requires two crystals of the same lot connected in parallel. That is the reason because you have been suggested to use the new 4915 kHz crystal to replace the non-critical X6 and to use the original X6 crystal as same lot companion of the original X5 crystal. By this way you can minimise the risks of any misplaced oscillations.



RX SSB board assembly

Install all components of the RX section (see schematic and top layout). The SMD components on the bottom side of the SSB board are pre-assembled.

When ready, the SSB board can be plugged on the K1 RF board trough the Noise blanker and new added connectors (no wires are necessary).

RX alignment

Set V1 on the SSB board to 4.9 Vdc (test point, pin 2 - U1)
Set V2 on the SSB board to 1.1 Vdc (test point, pin 5 - U1)

Set filter 3 to 200 Hz (FL3) then adjust C12 for 4916.850 kHz (+/-50 Hz) for USB mod. (frequency test point, pin 7 - U3, verify Vpp > 200 mV)
Set filter 1 to 850 Hz (FL1) then adjust C11 for 4913.900 kHz (+/-50Hz) for LSB mod. (frequency test point, pin 7 - U3, verify Vpp > 200 mV)
Adjust C34 (filter FL2) for the best CW note (about 4913.300 kHz with 600 Hz Cw filter)
Set once again filter 1 and adjust again C12 for 4916.850 kHz.
Set filter 2 in the range 250 - 800 Hz to select the CW filter bandwidth preferred for CW operation.
Verify that relay RL1 goes switched "on" when FL1 or FL3 are selected.

Operation:

Press WPM+ and select FL1 (SSB filter with LSB is selected) to set your K1 into LSB mode
Press WPM+ and select FL3 (SSB filter with USB is selected) to set your K1 into USB mode
Select FL2 To set your K1 into CW mode.

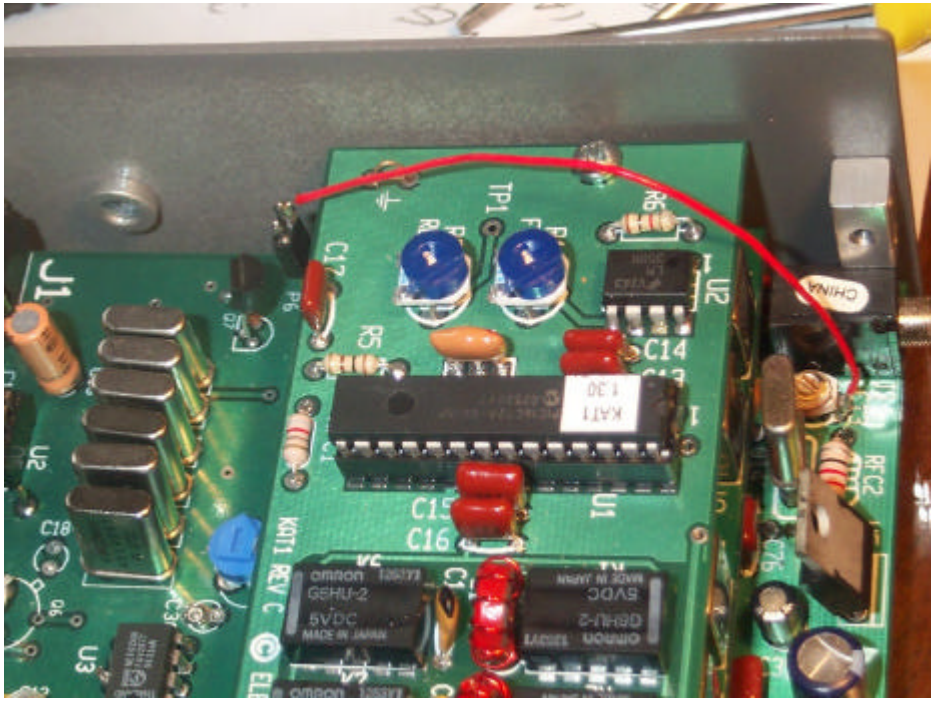
All 3 CW filters are still available for "CW only" mode if they are selected in the 250-800 Hz range.
In this case the SSB filters will be not activated

TX Part Assembly

Preliminary K1 RF Board Modification

Add the following components:

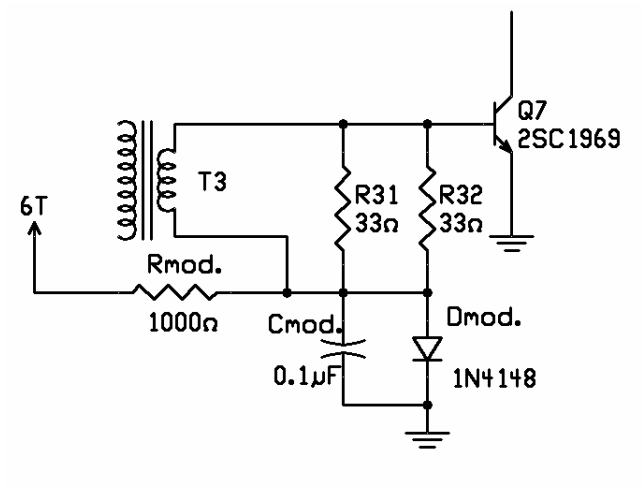
- Solder a wire (about 2 " (50mm) of length)into pin 6 of U8 on the RF board (you can solder the wire in the C13 side connected to pin 6. This wire must be connected with the P6 connector (pin n1) of the SSB mod. board.



- Add one connector pin (female) to have a 8V supply for the SSB modification board. (this supply voltage is available on the K1 RF Board next to the C18 capacitor, see page 8 for reference)

- The following components should be inserted into the K1 RF board to change the operating mode of class the final TX amplifier into AB-Operation. (instead of Class-C operation). This changes are necessary to improve the linearity of the final power amplifier which improves greatly the SSB signal quality. To change the TX amplifier into AB-Mode follow these steps:
    - remove R31 and R32 from its GND connection (do not remove the Q7 base connection !)
    - add a standard diode (e.g. 1N4148) in series to R31 , R32 . Solder the Cathode to GND and anode to R31/32 (the cathode its where the “ring” of the diode is located)
    - polarize the diode via the 6T voltage (available on the R38/R28 terminals) through an 1K ohm resistor.
    - Unsolder wire no. 4 of T3 from GND and connect it to the anode of the previously installed diode.
    - bypass the diode with a 0.1 capacitor

For more clarity the Class AB modification is shown in the following schematic diagram of the performed modification. :



Class-AB Modification of the K1 final TX amplifier

TX board assembly:

Unplug the SSB board from the K1 RF board and complete its assembly with both TX and RX parts (see complete list for all missing parts).
When ready, plug-in it back on the K1 RF board.

TX alignment

Select K1 filter 1 or 3 then go in TX mode (see below) then adjust Potentiometer V4 for maximum carrier suppression (you can use a Scope or another Receiver)
In order to access the microphone jack J1 you need to drill a hole into the left side panel at the corresponding position of J1.
It is also possible to add a microphone jack on the back panel of your K1 and run a shielded cable from this jack to the K1 SSB board. For this purpose an additional 2-pin connector (in parallel to the jack J1) has been provided on the SSB board.
Plug the microphone into J1 (or the back panel jack, if preferred) then adjust the potentiometer V3 for a suitable mike sensitivity and SSB modulation. I suggest you to prefer an Electrete mike; I used a low cost PC Mike for sound card. The connector is compatible (3.5 mm Jack).

The BFO settings, must be revised for TX operation too:
Set filter 3 to 200 Hz (FL3) then adjust C12 for 4916.850 KHz (+/-50 Hz)for USB mod. (frequency test point, pin 7 - U3 , verify Vpp > 200 mV)
Set filter 1 to 850 Hz (FL1) then adjust 4913.900 KHz (+/-50 Hz)for LSB mod. (frequency test point, pin 7 - U3 , verify Vpp > 200 mV)
Adjust C34 (filter FL2) for the best CW note (about 4913.500 KHz)
Set once again filter 1 and adjust again C12 for 4916.850 KHz.
Switch on TX and verify the TX BFO offset setting (about 4914.1 KHz) (frequency test point, pin7 - U8 of the K1 RF board)
This CW offset set-up can be made as described at the page 47 of the K1 manual, or by using an AF spectrum analyser (many AF spectrum analysers are available on line, they use the PC Sound blaster)
To perform this test you need to install the jumper parallel to the zener Z1 and close the S2 switch (on the K1 board) on the test position.

The SSB signal can be verified with a scope at the P6 connector as following (not strictly necessary):

- Set LSB (FL1) or USB (FL3): Then set V4 for minimum carrier level without modulation (alternatively you can use an additional receiver to minimise the suppressed carrier)
- The SSB signal at 4915 kHz can be observed at this point (>700 mV during modulation)

The SSB quality can be also verified on the K1 speaker:

- place a short circuit by the supplied Jumper (P8) in parallel to the zener Z1.
- Turn the switch S2, (bottom of the K1 RF board) in the Test position.
- Verify the SSB modulation on the K1 speaker (I suggest you to use head phones in order to avoid a noisy audio feedback).
- Remember to turn S2 back to the Operation position and to remove the jumper on Z1 at the end of this test.

OPERATION:

Reception:
Press WPM+ and select FL1 (SSB filter with LSB is selected) to set your K1 into LSB mode
Press WPM+ and select FL3 (SSB filter with USB is selected) to set your K1 into USB mode
Select FL2 To set your K1 into CW mode.

All 3 CW filters are still available for "CW only" mode if they are selected in the 250-800 Hz range.
In this case the SSB filters will be not activated.

Transmission:
The PTT function is performed through the key jack. Before to use it, it is necessary this set-up:

- Set hand key (**Hnd** on the menu)
- Set sidetone level to 0 (**Stl** on the menu)

A special interface with two 3.5 mm stereo connectors must be made available in the case you use a standard Mike with PTT.

Autotuner compatibility:
You can perform the tuning as described in the K1 manual in CW mode. No problems if you use the internal autotuner.

PSK31 compatibility
No problems to use PSK31 or RTTY transmission.
The data tone must be input to the mike jack.
Adjust carefully the PSK31 modulation to avoid overload in the AF or RF section.Overload can generate high IMD products

SSB modification performance

RX & TX crystal filter bandwidth:	2.4 KHz @ 3 dB
SSB carrier suppression:	> 40 dB
Sideband suppression:	> 50 dB
TX Spurious and harmonic suppression	> 50 dB
TX IMD (third order)	> 20 dB
TX power:	> 5 Watts
Frequency coverage:	250 KHz

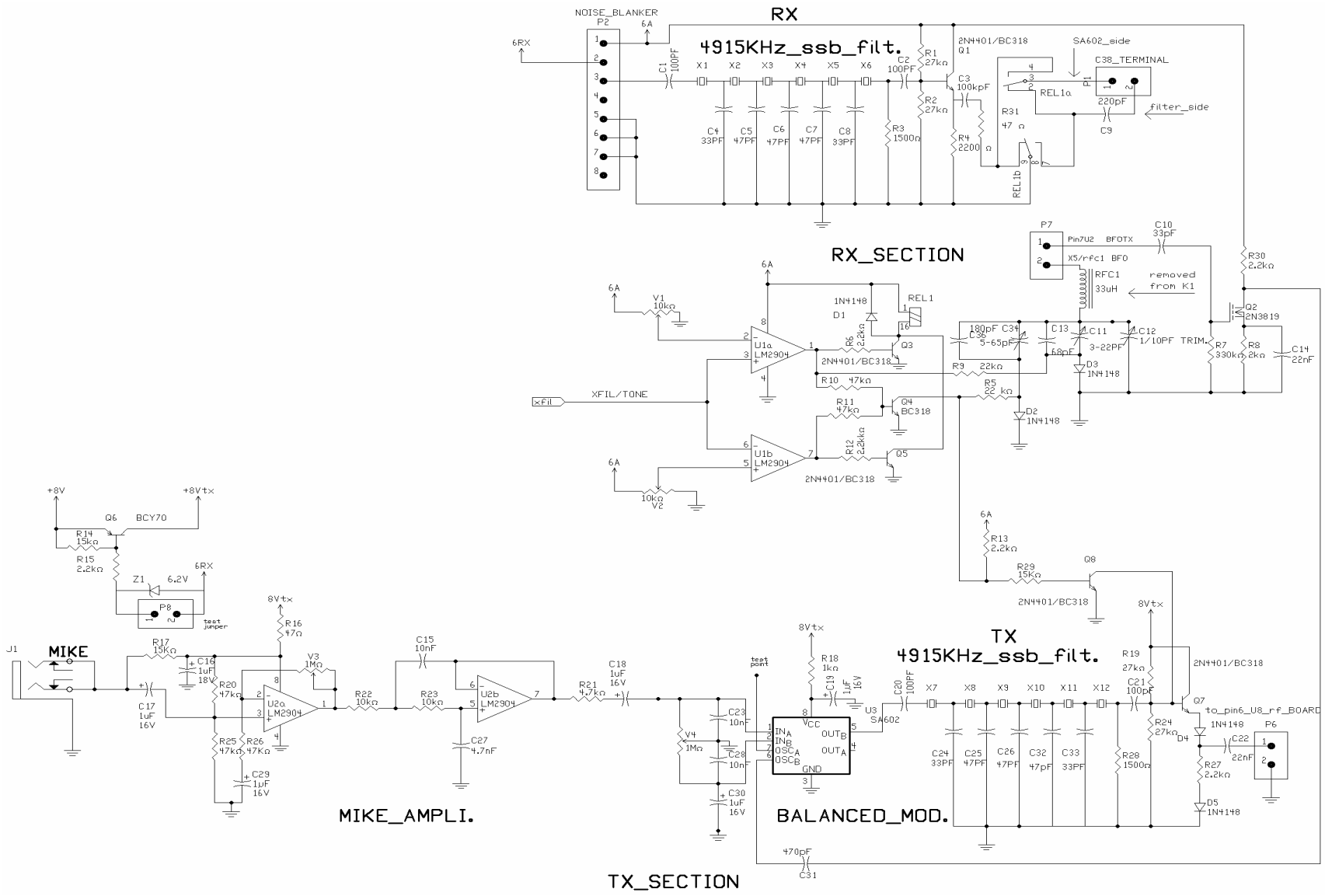
Overall Power requirement RX: 85 mA USB & LSB, 65 mA CW

ED1 to ED2 K1 SSB Mod. Changes.

- C65 no change value. C65 = 22 pF as original
- Isn' t necesary remove the X6 quartz
- Add a 56 pF trimmer as C11. Install it on the top board from RFC1 and D3 anode (this mode is necessary for a better LSB freq. Setup)
- On the SMD side C11 has removed
- C13 become 68 pF (smd side)
- Cut the track from Q8 collector and U3 Pin 1 (cut near U3)
- Connect a wire from Q8 collector and Q7 base
- Add 1N4148 diode series with Q7 emitter
- Add 1N4148 diode from R27 and GND.
- Isn't necesary use a shield cable from the SSB board and the K1 RF board, but only a wire 2 " long
- R27 become 47 KHohm (necessary to reduce the Mike amplification)
- Zener Z1 become 6.2 V
- Verify R5 and R9 must be 22 Khohm
- Shortcircuit to D4 (old schematic)

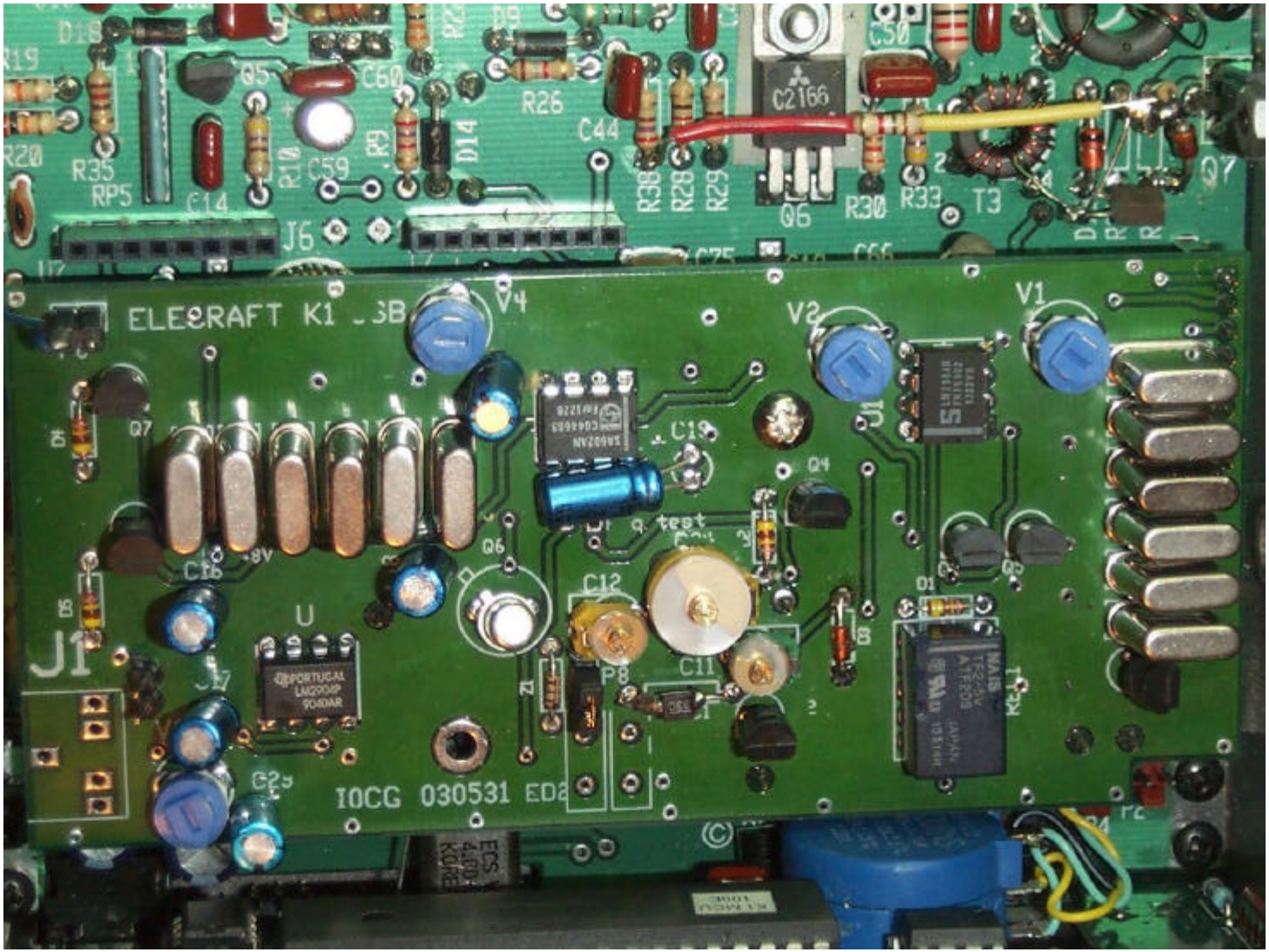
See the actual schematic for detail.

Mike installation

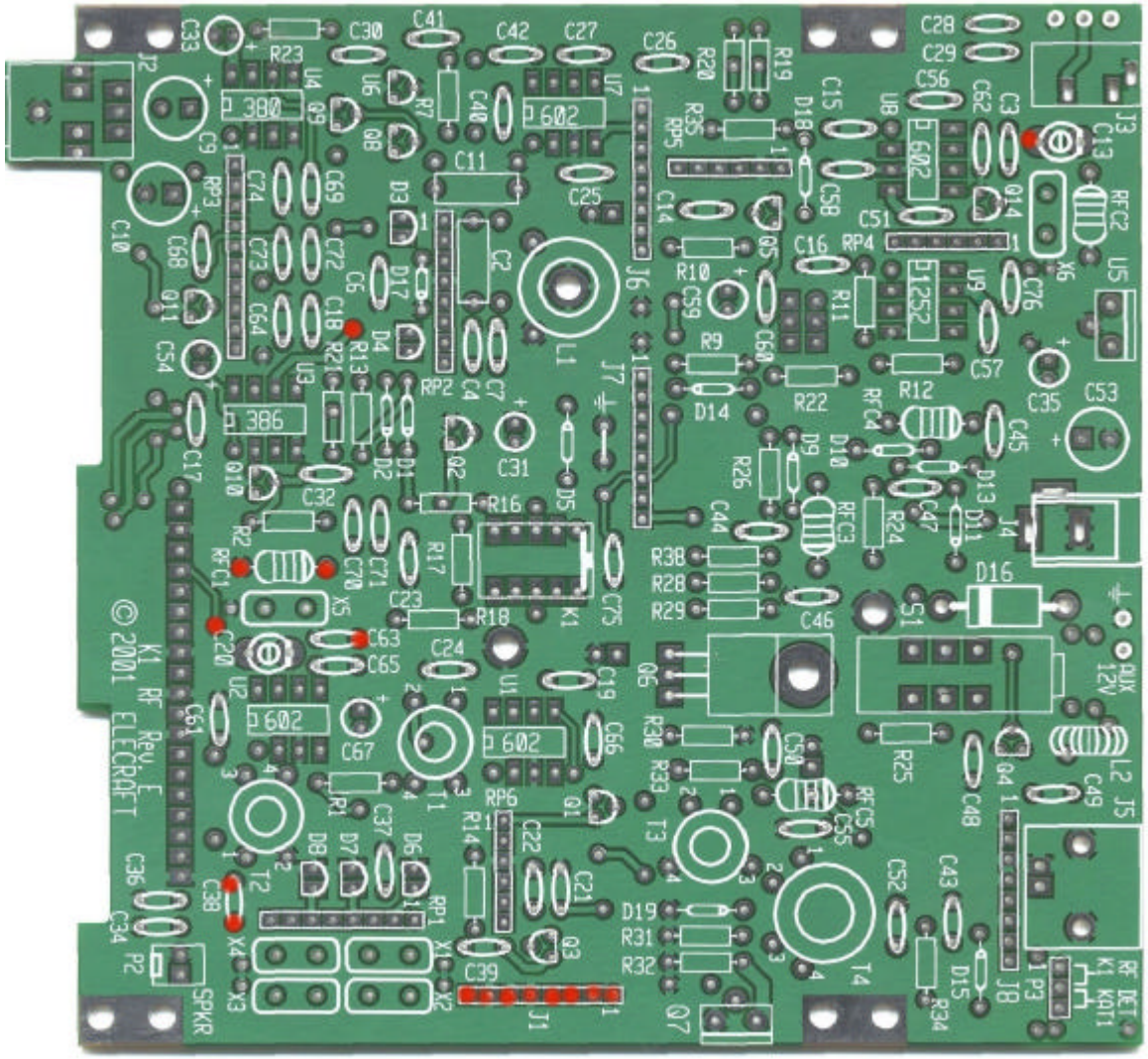


Schematic Diagram of RX and TX K1 SSB modification.

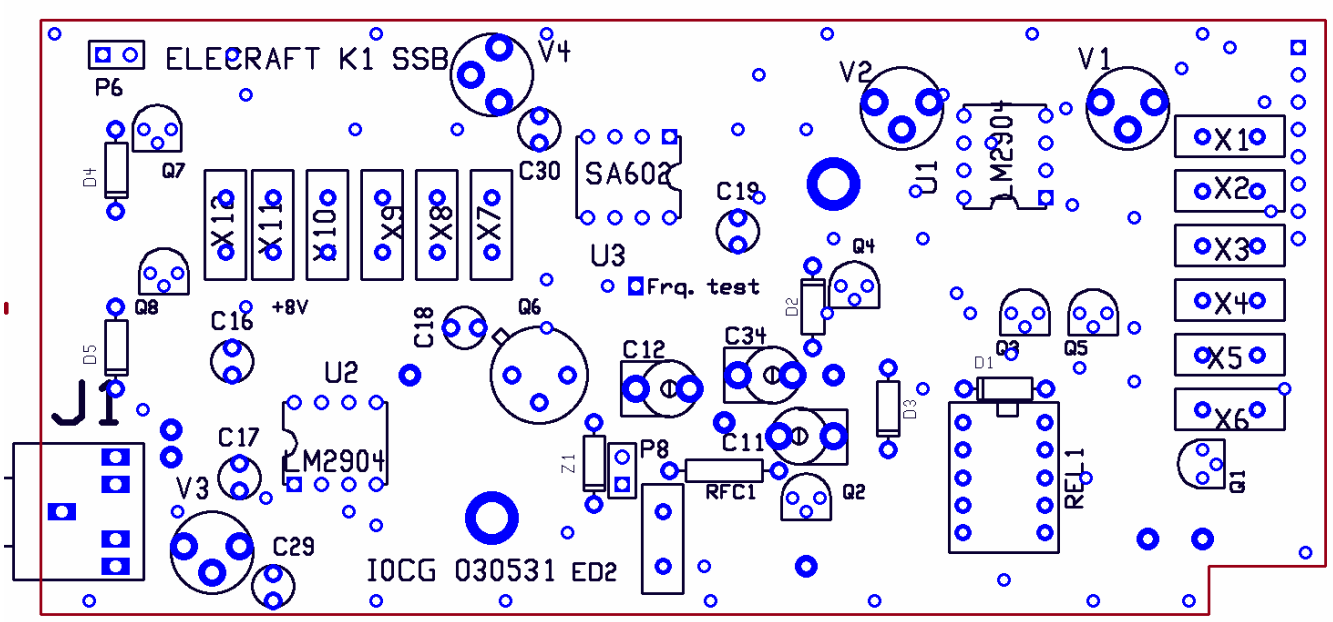
Ed2



Ed2 PCB (see the Class AB mod.)

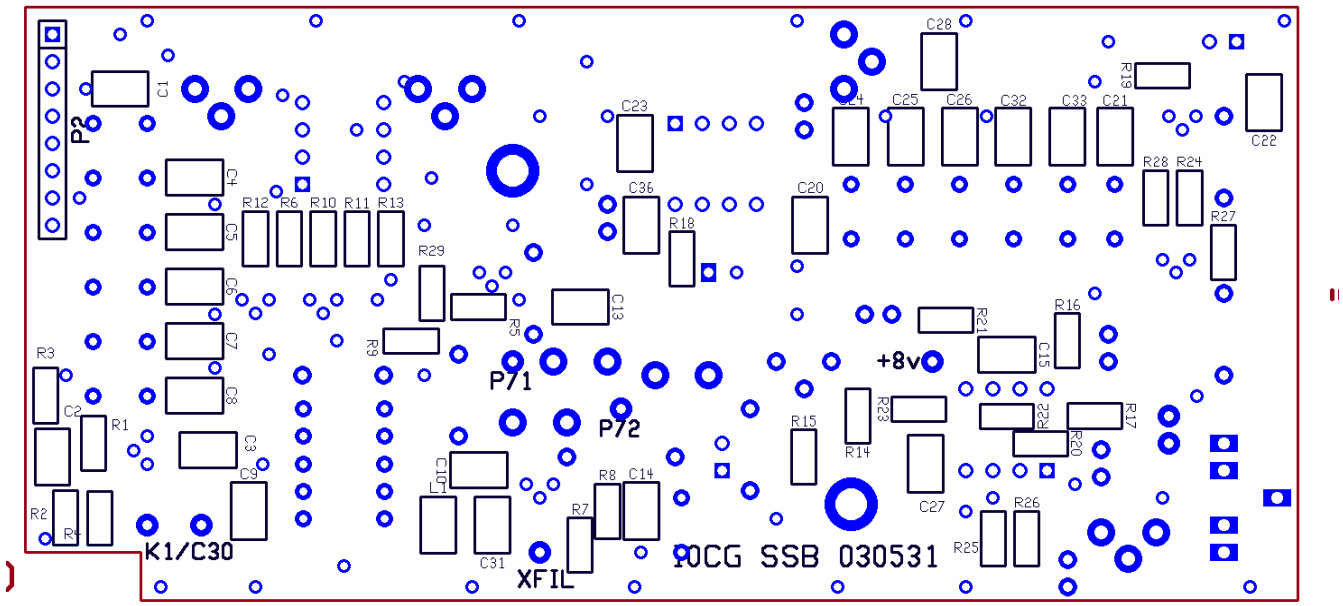


The red points indicate the locations at which (female) connection pins must be added on the K1 RF Board.



K1 SSB modification board – upper side layout

ATTENTION!: ERRATE POLARIZATION INDICATION on C16 and C17 on PCB only (schematic is correct)



Bottom layout . The SMD components are pre-assembled on the board

On this side only the following non-surface mount components are installed:
(“male” connectors used to plug the modification board into the K1)

- 8 pin connector P2
- 2 pin connector K1/c30
- 1 pin connector XFIL
- 1 pin connector P7_1
- 1 pin connector P7_2
- 1 pin connector +8V

SSB – Modification Parts List

NAME	VALUE	RS - Code
C1	100PF	
C2	100PF	
C3	100kpF	
C4	33PF	
C5	47PF	
C6	47PF	
C7	47PF	
C8	33PF	
C9	220pF	
C10	33pF	
C11	3-22pF TRIM (green)	
C12	1/10PF TRIM. (yellow)Rs-code 125-957	
C13	47pF	
C14	10nF	
C15	10nF	
C16	1 UF	
C17	1 UF	
C18	1 UF	
C19	1 UF	
C20	100PF	
C21	100pF	
C22	10nF	
C23	10nF	
C24	33PF	
C25	47PF	
C26	47PF	
C27	4.7nF	
C28	10nF	
C29	1 UF	
C30	1uF	
C31	1000pF	
C32	47pF	
C33	33PF	
C34	5/65pF	TRIM. (big yellow) Rs-code 125-957
C35	33pF	
C36	100 pF	
D1	1N4148	
D2	1N4148	

D3	1N4148	
D4	1N4148	
D5	1N4148	
J1	NC/3-Ckt	
L1	100uH	
P1	2-pin	
P2	8-pin	
P6	2-pin	
P7	2-pin	
Q1	2n4401	Rs-code 299-654
Q2	2N3819	Rs-code 293-713
Q3	2n4401	
Q4	BC318	
Q5	2n4401	
Q6	BCY70	Rs-code 294-609
Q7	2n4401	
Q8	2n4401	
R1	27k OHM	
R2	27k OHM	
R3	1500 OHM	
R4	2200 OHM	
R5	22 kOHM	
R6	2.2 kOHM	
R7	330 kOHM	
R8	2.2 kOHM	
R9	22k OHM	
R10	47k KOHM	
R11	47k KOHM	
R12	2.2 kOHM	
R13	2.2 kOHM	
R14	15k OHM	
R15	2.2 kOHM	
R16	47 OHM	
R17	15 KOHM	
R18	1 kOHM	
R19	22 kOHM	
R20	47 kOHM	
R21	4.7 kOHM	
R22	10 kOHM	
R23	10 kOHM	
R24	22 kOHM	
R25	47 kOHM	

R26	47K OHM		
R27	2.2 kOHM		
R28	1500 OHM		
R29	15K OHM		
R30	2.2 kOHM		
REL1	TF2-5V NAIS		Rs –code 113-8881
RFC1			
U1a	LM2904		RS-code 810-273
U1b			
U2a	LM2904		RS-code 810-273
U2b			
U3	SA602		RS-code 606-765
V1	10k OHM	Pot	Rs-code 187-539
V2	10k OHM	Pot	Rs-code 187-539
V3	1M OHM	Pot	Rs-code 187-595
V4	1M OHM	Pot	Rs-code 187-595
X1	XTAL	4915KHz	RS-code 300-990
X2	XTAL	4915KHz	RS-code 300-990
X3	XTAL	4915KHz	RS-code 300-990
X4	XTAL	4915KHz	RS-code 300-990
X5	XTAL	4915KHz	RS-code 300-990
X6	XTAL	4915KHz	RS-code 300-990
X7	XTAL	4915KHz	RS-code 300-990
X8	XTAL	4915KHz	RS-code 300-990
X9	XTAL	4915KHz	RS-code 300-990
X10	XTAL	4915KHz	RS-code 300-990
X11	XTAL	4915KHz	RS-code 300-990
X12	XTAL	4915KHz	RS-code 300-990
Z1	Zener	6.2 V	