ILER-20 v3

QRP SSB transceiver in Kit

Manual assembly

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Thank you for building the ***ILER-20 v3*** SSB Transceiver kit

Have fun assembling it and enjoy QRP! 73 Javier Solans, ea3gcy

CONTENTS

INTRODUCTION

What is the significance of ILER? A little bit history…

The origin of LLEIDA goes back to 5th century B.C. when the Iberian people of the ILERGETAS settled on top of the "Cerro de la Seu Vella" (Hill of the Old See) and founded the city of ILTIRDA. Their most well-known leaders were Indibil and Mandonio, who defended against the Carthaginians and Romans, but were defeated in the year 205 B.C., and thereafter the city was Romanized and renamed ILERDA.

LLEIDA is the current name of this city in the northeast of Spain.

Photo: Seu Vella de Lleida

ILER-20

The circuit of the ILER kits is a Spanish re-design of the 80-meter transceiver “Antek” by Andy SP5AHT published in the magazine “Swiat Radio”. By switching the LO and the BFO between the two NE602’s, each one carries out two different functions, depending on whether it is in TX or RX mode. One NE602 functions as a receive mixer and DSB generator, and the other NE602 works as a transmit mixer and SSB demodulator.

A quartz crystal controlled local oscillator (LO) tunes a segment with a range of about 50 KHz.

Its low power consumption and robustness make it ideal for SOTA activities and other portable radio operations that require power supplied by small batteries.

The philosophy of this equipment is:

"Put in just the minimum to make it work, and work well!”

There are only two controls: volume and tuning, which are sufficient for enjoying the pleasure of QRP!

Thanks

To Andy, SP5AHT for his important contribution in the world of amateur radio.

To Gilles F1BFU for the translation of this manual into English and French and Marlin KC0O for reviewing the English version.

To Jon Iza, EA2SN for his didactic reports and contribution of technical data.

To Luis EA3WX, Juan EA3FXF, Jaime EA3HFO, Alfonso EA3BFL for the help they gave in making this kit a reality, from the first prototype to the current version ILER-40 v3.

To "eaqrpclub.com" for keeping the "cackling" flame lit even in difficult times.

SPECIFICATIONS

GENERAL:
Frequency coverage: VXO that tunes in a segment of about 50kHz of the 20M band. It is possible to increase coverage, but decrease stability. (“ILER-DDS” or “ARDU-5351” kit option)
Frequency Control: Oscillator using VXO quartz crystals. Two 10.240MHz crystals.
Tuning: Varactor diode.
Antenna: 50 ohms
Power: 12-14VDC, less than 50mA in reception, 1000-1200mA in transmission.
Optional controls: RX dimmer potentiometer, CAG and S-METER with the “U-AGC/SMETER kit.
External connections: micro / ptt, speaker, antenna, DC input.
Board dimensions: 100x140 mm.

TRANSMITTER:
RF output: 4 W (13.8V)
2nd harmonic output: -50dBc below the fundamental.
Other spurious signals: -50dBc or better below the fundamental.
Carrier suppression: better than -45dBc
T / R switching: Relays.
Microphone: electret type (capsule included in the kit)

RECEIVER:
Type: Superheterodyne. Balanced mixer
Sensitivity: 0.2uV minimum discernible signal.
Selectivity: 4-pole glass ladder filter. 2.2KHz nominal bandwidth.
FI frequency: 4.000MHz.
Optional CAG with the “U-AGC/SMETER” kit.
Audio output: 250mW @ 4-8ohms.

PLEASE READ ALL ASSEMBLY INSTRUCTIONS COMPLETELY, AT LEAST ONCE BEFORE YOU BEGIN.

TIPS FOR BUILDERS WITH LITTLE EXPERIENCE

Tools required:

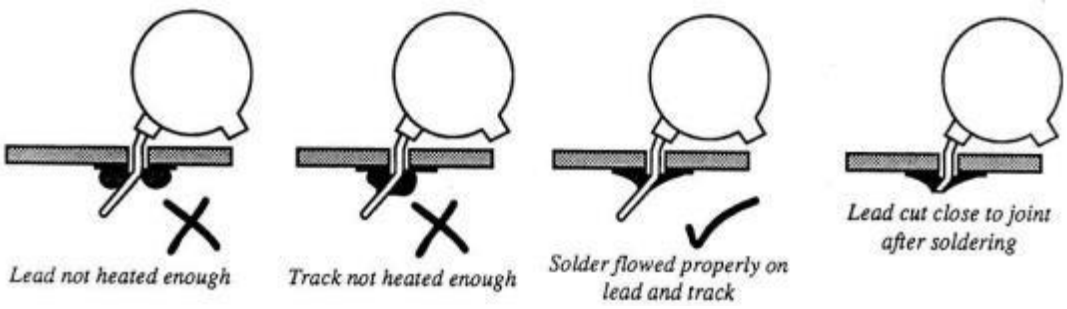
- Fine-tip soldering iron of about 30W, small wire cutters for cutting component leads, wire strippers, long-nose pliers, needle-nose pliers, X-Acto knife, screwdriver for M3 screws, alignment tool for adjusting IF transformers.
- You will need a good light and a magnifying glass to see the fine print on the components and other assembly details.

Instruments required:

- Multimeter, frequency counter or HF receiver, RF power meter, dummy load of about 10W - 50ohms, RF signal generator (desirable but not essential).

Soldering:

There are two essential things to keep in mind to ensure the proper functioning of a kit. The first is to put the component into its proper place on the circuit board, the second is good soldering.



To solder properly, you must use a high-quality solder for electronics and the correct type of soldering iron. Use a small soldering iron that has a fine, pointed tip. The soldering iron should be about 30 watts (if it is not thermostatically controlled). Use only solder intended for electronic soldering; NEVER use extra flux. You should hold the hot soldering iron in contact with both the circuit board and the component lead for about two seconds to heat them up. Then, keeping the soldering iron in place, touch the solder at the junction of the component lead and circuit board trace and wait about two seconds or so until the solder flows between the lead and the trace to form a good joint. Now remove the soldering iron. The soldering iron should have been in contact with the joint for a total time of about 4 seconds. After soldering each joint, you should clean the soldering tip, removing any excess solder. This prevents mixing in old solder and residues from previous soldering operations.

Finding the correct component:

IC's

The component outline for the IC printed on the circuit board has a "U" shaped notch on one end, indicating the end at which pin 1 of the IC is located. There is a similar notch on one end of the IC socket that should be oriented over the "U" printed on the circuit board. Finally, pin 1 of the IC is also marked with a small dimple or dot; this end of the IC should be oriented towards the notch in the IC socket or the "U" of the component outline.

Diodes
Be careful to observe the correct polarity of the diodes. There is a dark-colored band towards one end of the diode. This band should be oriented towards the line printed on the component outline of the circuit board.

Electrolytic capacitors:
These must be placed with the correct polarity. The positive lead (+) is always the long lead. The negative terminal (-) is the short lead and is marked by a stripe on the body of the capacitor. Make sure that the positive lead of the capacitor goes through the hole marked with a "+" on the circuit board.

Toroids:
You may find it convenient to wind and prepare all the toroids before beginning to mount the components. That way you won't have to stop and possibly lose concentration while winding them.
This is the part of the construction that some consider to be the most difficult. I personally find it to be one of the easiest stages, and it can even be relaxing. Look for the most appropriate moment to do it, and most importantly, take your time. The drawings, photos and instructions in the manual will illustrate and make the process easier.

LIST OF COMPONENTS BY VALUE/QUANTITY

Resistor list				
Qty	Value	Checked	Ref.	Identified
1	1		R17	brown-black-gold
2	10		R18, R19	brown-black-black
5	22		R7, R9, R46, R49, R50	red-red-black
5	100		R15, R27, R38, R40, R43	brown-black-brown
1	220		R23	red-red-brown
1	330		R44	orange-orange-brown
4	470		R3, R8, R36, R48	yellow-violet-brown
9	1K		R10, R11, R21, R22, R26, R28,R32, R37, R42,	brown-black-red
1	1K2		R35	brown-red-red
1	1K5		R47	brown-green-red
1	No used		R41	
3	4K7		R2, R39, R45	yellow-violet-red
7	10K		R1, R4, R12, R13, R16, R20, R51	brown-black-orange
6	22K		R24, R25, R30, R31, R33, R34	red-red-orange
2	47K		R5, R6,	yellow-violet-orange
1	100K		R29	brown-black-yellow
1	220K		R14	red-red-yellow
2	10K		P1, P2 adjustable resistor	adjustable resistor 103
1	10K		P3 Potentiometer	Potentiometer 103
1	50K		P4 Potentiometer	Potentiometer 503

Capacitor list				
Qty	Value	Checked	Ref.	Identified
6	1n		C5, C28, C40, C49, C50, C56	102 or 0.001
4	10n		C30, C58, C59, C64	103 or 0.01
26	100n		C2, C4, C12, C19, C21, C22, C24, C25, C29, C33, C37, C41, C43, C44, C45, C51, C52, C57, C60, C62, C63, C65, C66, C67, C72, C73	104 or 0.1
2	470n		C1, C6,	474 or 0.47
2	8p2		C9, C54	8p2 or 8.2
6	22p		C7, C14, C15, C16, C17, C18	22
1	47p		C48	47
4	82p		C8, C10, C53, C55	82
2	100p		C46, C47	101 or 100 or n10
4	220p		C13, C20, C38, C39	221 or 220 or n22
2	180p		C68, C71 Polystyrene	180 polystyrene
2	390p		C69, C70 Polystyrene	390 polystyrene
1	1uF		C11 (elec.)	1uf
7	10uF		C3, C23, C26, C27, C31, C42, C61 (elec.)	10uf
3	100uF		C32, C34, C36 (elec.)	100uf
1	220uF		C35 (elec.)	220uf
1	60p		CV1 Trimmer (adjustable cap brown)	Trimmer (brown)

Semiconductor list				
Qty	Type	Checked	Ref.	Identified
Transistors				
1	P2222		Q1	P2222
1	BD135		Q2	BD135
1	2SC1969		Q3	2SC1969
5	BC547		Q4, Q5, Q6, Q7, Q8	BC547
Integratedcircuits				
2	NE602		IC1, IC2	NE602 or SA602
1	UA741		IC3	UA741
1	LM386		IC4	LM386
Diodes				
2	6V2		D1, D2	6V2
1	9V1		D3	9V1
5	1N4148		D4, D5, D6, D7, D8	4148
1	1N4001/7		D9	4001 or 4007
1	47V/1W		D10	47V
1	BY255		D11	BY255
1	VD		SVC236 (Factory soldered)	Varactor diode

Inductor/RF Transformer/Crystal/Relay list				
Qty	Value	Checked	Ref.	Identified
4	1u2H		L1, L2, L5, L6	1u2H
1	68uH		L3	blue-grey-black
1	10uH		L7	brown-black-black
1	T68-2		L4	--
2	FT37-43		L8, L9	--
3	T37-6		L10, L11, L12	--
5	4.000 MHz.		X1, X2, X3, X4, X5	4.000
2	10.240MHz.		X6, X7	--
2	DPDT Relay		RL1, RL2	Huigang HRS2H 12V
1	SPDT Relay		RL3	Omron G5V-1 12V

Hardware				
Qty	Value	Checked	Ref.	Identified
1	BNC socket		BNC PCB socket	--
2	Jack socket		Stereo PCB Jack 3.5mm socket	--
1	Supply socket		Power supply PCB 2.1mm socket	--
1	Switch		SPDT PCB switch toggle	--
13	Male pins strip		3 + 2 + 2 + 2 + 2 + 2 no polarized strip pins	--
1	Male pin socket		5 pin male polarized socket	--
3	Jumpers		J1, J2, RXATT/AGC Jumpers	--
4	IC DIP-8 socket		8 pins IC socket	--
1	Q3 Heatsink		Heatsink to Q3	--
1	Q2 Heatsink		Heatsink to Q2 (pair)	--
2	M3x10 Screws		10mm M3 screw	--
4	M3x4 Screws		4mm M3 screw	--
6	M3 Nuts		M3 nut	--
2	M3 washer		Metal M3 washer	--
1	Insulating		Plastic insulator through to Q3	--
2	Mica insulator		Mica insulator to Q2 and Q3	--
4	Hex spacers		Hexagonal M3 5mm spacers	--
1	Plastic washer		12 mm diameter. Plastic washer to L6	--
1	Plastic screw		M3x12 plastic screw to L6	--
1	Plastic nut		M3 plastic nut	--
1	Microphone		Electret Microphone capsule	--
112cm	0.3mm wire		Enameled Wire 0.3mm 112cm.	
140cm	0.5mm wire		Enaled Wire 0.5mm 140cm.	
1	PCB		ILER+ PCB (printed circuit board)	--

LIST OF INDIVIDUAL COMPONENTS

Resistors						
Checked		Ref.	Value	Ident./Comment	Circuitsection	Located
		R1	10K	brown-black-orange		H-8
		R2	4K7	yellow-violet-red		G-8
		R3	470	yellow-violet-brown		G-8
		R4	10K	brown-black-orange		I-7
		R5	47K	yellow-violet-orange		H-6
		R6	47K	yellow-violet-orange		H-6
		R7	22	red-red-black		I-4/5
		R8	470	yellow-violet-brown		I-3
		R9	22	red-red-black		I-3
		R10	1K	brown-black-red		I-7
		R11	1K	brown-black-red		I-9
		R12	10K	brown-black-orange		J-8
		R13	10K	brown-black-orange		J-9
		R14	220K	red-red-yellow		J-9
		R15	100	brown-black-brown		J/K-10
		R16	10K	brown-black-orange		M-8
		R17	1	brown-black-gold		K-9
		R18	10	brown-black-black		M-9
		R19	10	brown-black-black		B-10
		R20	10K	brown-black-orange		E-10
		R21	1K	brown-black-red		N-7
		R22	1K	brown-black-red		N-7/8
		R23	220	red-red-brown		J-8
		R24	22K	red-red-orange		L-7
		R25	22K	red-red-orange		L-6
		R26	1K	brown-black-red		K-6/7
		R27	100	brown-black-brown		K-6
		R28	1K	brown-black-red		N-6/7
		R29	100K	brown-black-yellow		N-5/6
		R30	22K	red-red-orange		K-3
		R31	22K	red-red-orange		L-4/5
		R32	1K	brown-black-red		L-4/5
		R33	22K	red-red-orange		K-3
		R34	22K	red-red-orange		K-4
		R35	1K2	brown-red-red		K-4
		R36	470	yellow-violet-brown		K-5
		R37	1K	brown-black-red		I-2
		R38	100	brown-black-brown		K-1
		R39	4K7	yellow-violet-red		J-2
		R40	100	brown-black-brown		H-1
		R41		No used		G-2
		R42	1K	brown-black-red		F-3
		R43	100	brown-black-brown		G-3
		R44	330	orange-orange-brown		F-2
		R45	4K7	yellow-violet-red		F-2
		R46	22	red-red-black		D/E-1
		R47	1K5	brown-green-red		E-3/4
		R48	470	yellow-violet-brown		C-3
		R49	22	red-red-black		A-4
		R50	22	red-red-black		A-3
		R51	10K	brown-black-orange		E-8
		P1	10K	adjustable resistor 103		H-9
		P2	10K	adjustable resistor 103		H-5
		P3	10K	Potentiometer103		N-9
		P4	50K	Potentiometer 503		N-5/6

Capacitors						
Checked		Ref.	Value	Ident./Comment	Circuitsection	Located
		C1	470n	474or 0.47		H-8
		C2	100n	104or 0.1		G-9
		C3	10uF	10uF		H-9
		C4	100n	104or 0.1		E-5
		C5	1n	102 or 0.001		H/I-10
		C6	470n	474 or 0.47		H-8
		C7	22p	22		F/G-7
		C8	82p	82		E-9
		C9	8p2	8p2 or8.2		E-8
		C10	82p	82		E-9
		C11	1uF	1uF		I-7
		C12	100n	104		H-6
		C13	220p	221 or 220		I/J-6
		C14	22p	22		G-7
		C15	22p	22		G-6
		C16	22p	22		G-5
		C17	22p	22		G-5
		C18	22p	22		G-4
		C19	100n	104 or 0.1		G-3
		C20	220p	221 or 220		J-5
		C21	100n	104 or 0.1		I/J-4
		C22	100n	104 or 0.1		I/J-3
		C23	10uF	10uF		H-4
		C24	100n	104 or 0.1		I-8
		C25	100n	104 or 0.1		I-8
		C26	10uF	10uF		K-8
		C27	10uF	10uF		J-10
		C28	1n	102 or 0.001		I-9
		C29	100n	104 or 0.1		L-8
		C30	10n	103 or 0.01		M-9
		C31	10uF	10uF		K-10
		C32	100uF	100uF		L-10
		C33	100n	104 or 0.1		M-9
		C34	100uF	100uF		M-10
		C35	220uF	220uF		J-7
		C36	100uF	100uF		E-10
		C37	100n	104 or 0.1		K-8
		C38	220p	221 or 220		K-7
		C39	220p	221 or 220		L-6
		C40	1n	102 or 0.001		K-7
		C41	100n	104 or 0.1		L-7/8
		C42	10uF	10uF		M-7
		C43	100n	104 or 0.1		M-4/5
		C44	100n	104 or 0.1		N-4/5
		C45	100n	104 or 0.1		M-3/4
		C46	100p	101 or 100		M-4/5
		C47	100p	101 or 100		L-4/5
		C48	47p	47		K-4/5
		C49	1n	102 or 0.001		J-4
		C50	1n	102 or 0.001		H/I-3
		C51	100n	104 or 0.1		G-3
		C52	100n	104 or 0.1		H-1
		C53	82p	82		J-1
		C54	8p2	8p2 or 8.2		H/I-2
		C55	82p	82		H-1
		C56	1n	102 or0.001		F-1
		C57	100n	104 or 0.1		F-3
		C58	10n	103 or 0.01		E-2
		C59	10n	103 or 0.01		D-1

		C60	100n	104 or 0.1		E-4
		C61	10uF	10uF		E-5
		C62	100n	104 or 0.1		E/F-3
		C63	100n	104 or 0.1		C-2
		C64	10n	103 or 0.01		D-3/4
		C65	100n	104 or 0.1		C-5
		C66	100n	104 or 0.1		E-3
		C67	100n	104 or 0.1		E-4
		C68	180p	180 polystyrene		E-6/7
		C69	390p	390 polystyrene		D-6
		C70	390p	390 polystyrene		C/D-6
		C71	180p	180 polystyrene		B/C-6
		C72	100n	104 or 0.1		I-5/6
		C73	100n	104 or 0.1		C-9
		CV1	60p	Trimmer(Brown)		L-5

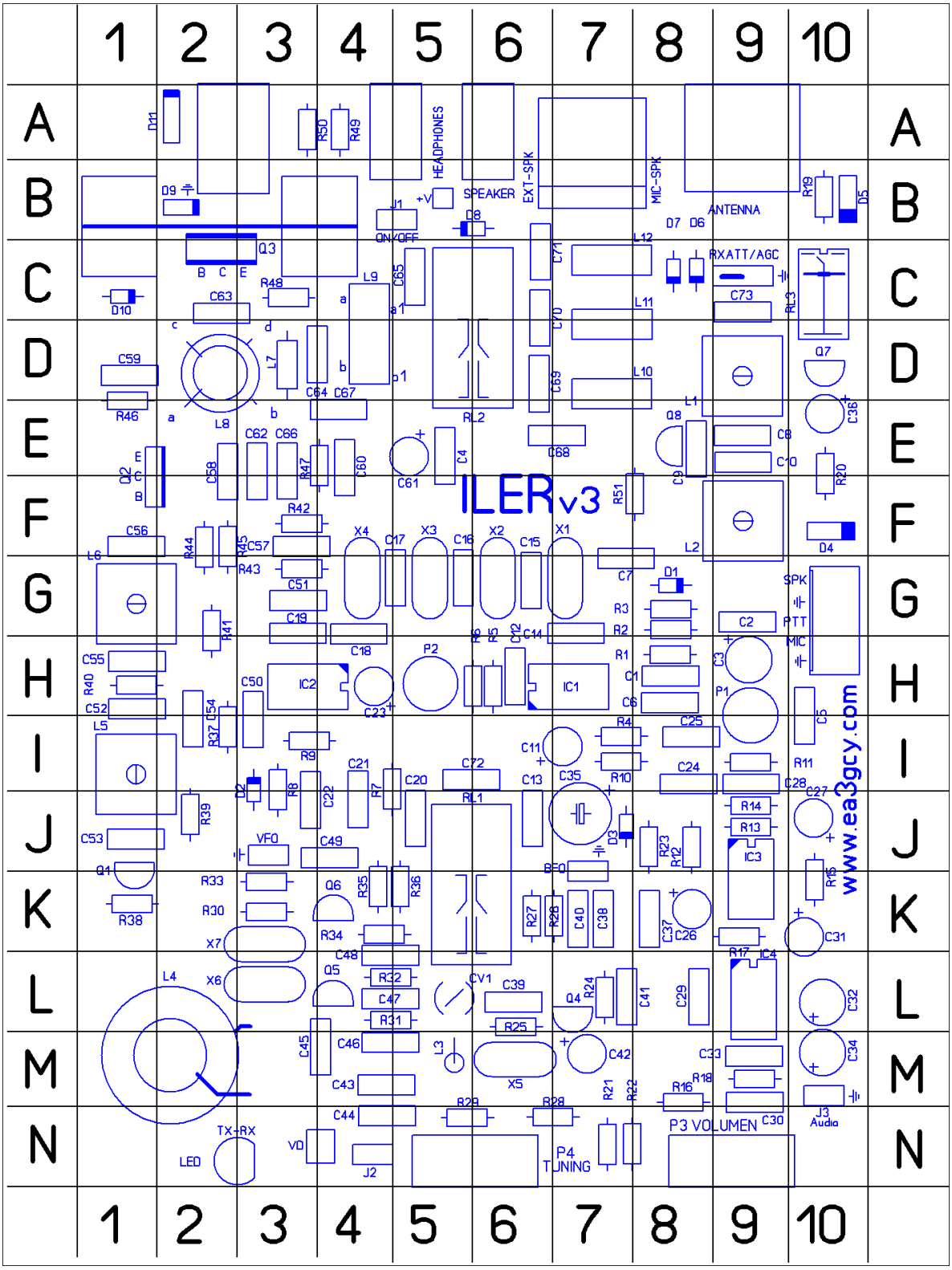
Crystals						
Checked		**Ref.**	**Frequency**	**Ident./Comment**	**Circuitsection**	**Located**
		X1	4.000 MHz		IF filter	F-7
		X2	4.000 MHz		IF filter	F-6
		X3	4.000 MHz		IF filter	F-5
		X4	4.000 MHz		IF filter	F-4
		X5	4.000 MHz		BFO	M-6
		X6	10.240 MHz		VXO	L-3
		X7	10.240 MHz		VXO	K-3

Semiconductors						
Checked		**Ref.**	**Type**	**Ident./Comment**	**Circuit section**	**Located**
		Transistors				
		Q1	P2222	P2222		J-1
		Q2	BD135	BD135		E/F-1
		Q3	2SC1969	2SC1969		C-2/3
		Q4	BC547	BC547		L-7
		Q5	BC547	BC547		L-4
		Q6	BC547	BC547		K-4
		Q7	BC547	BC547		D-10
		Q8	BC547	BC547		E-8
		IC's				
		IC1	NE602	NE602 or SA602		H-7
		IC2	NE602	NE602orSA602		H-3
		IC3	UA741	UA741		J-9
		IC4	LM386	LM386-N8		L-9

		Diodes				
		D1	6V2			G-8
		D2	6V2			I/J-3
		D3	9V1			J-7
		D4	1N4148	4148		F-10
		D5	1N4148	4148		B-10
		D6	1N4148	4148		C-8
		D7	1N4148	4148		C-8
		D8	1N4148	4148		B-5/6
		D9	1N4001/7	4001 or 4007		B-2
		D10	47V 1W			C-1
		D11	BY255			A-2
		VD	SVC236	Varactor diode	VXO	N-3/4

Inductors/RF Transformers/Relay						
Checked		**Ref.**	**Value/Type**	**Ident./Comment**	**Circuitsection**	**Located**
		L1	1u2H	1u2H		D-9
		L2	1u2H	1u2H		F-9
		L3	68uH	blue-grey-black		M-5
		L4	T68-2	--		L/M-2
		L5	1u2H	1u2H		I-1
		L6	1u2H	1u2H		G-1
		L7	10uH	brown-black-black		D-3
		L8	FT37-43	--		D-2
		L9	FT37-43	---		C/D-4
		L10	T37-6	-		D/E-7
		L11	T37-6	--		D-7/8
		L12	T37-6	--		C-7/8
		Relés				
		RL1	RL1a/b	Huigang HRS2H 12V		J-5/6
		RL2	RL2a/b	Huigang HRS2H 12V		C-5/6
		RL3	RL3	Omron G5V-1 12V		C-10

140-QUADRANT COMPONENT LAYOUT MAP



ASSEMBLY

You can use the “individual parts list” or the “value/quantity parts list.” Using the “value/quantity parts list” is the quickest way to mount components since all the circuit board components of the same value or type can be placed one after the other. However, you will need the “individual parts list” to know how each component is identified and its location on the circuit board. Depending on your personal experience, you may prefer the individual parts list and feel more confident using it.

The 140-quadrant component layout map makes it very easy to find the location for all the components. After mounting each component, it can be marked off in the “checked” column.

It is highly recommended that an inventory be taken of all the components to make sure that everything can be located and is ready for assembly. Each builder may have his/her own method of organizing the components. One suggested method is to use a block of Styrofoam packing material and poke the components into it. The components can be sorted by type, value and size (ohms, micro-farads etc.).

IMPORTANT:

*If you are going to use the ILER-20 with the **ILER-DDS** or **ARDU-5351** kits, (www.ea3gcy.com) you do not need to assemble the VXO circuit built into the board. Therefore, do not mount the following components:*
L4, J2, Q5, Q6, X6, X7, P4 (potentiometer) R28, R29, R30, R31, R32, R33, R34, R35, C43, C44, C45, C46, C47, C48.

*If you are using the **ILER-DDS** you can leave the capacitor value **C49** at **1n** as indicated in the list of components.*
*If you are using the **ARDU-5351** you must replace **C49** with a **10p**f capacitor since the SI5351 module generates a stronger signal.*
The output signal of the ILER-DDS or ARDU5331 will be connected to the “VFO” terminals on the circuit board.

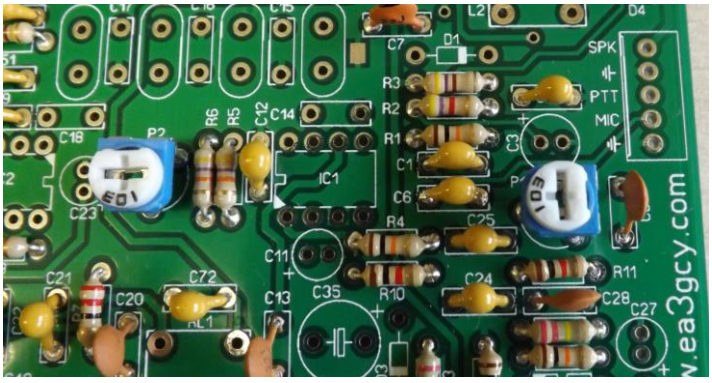
RECOMMENDED ASSEMBLY SEQUENCE

⇨ Resistors

The resistors are installed first. Mount all resistors and trimmers P1 and P2.
P3 and P4 are the volume and tuning potentiometers respectively; which should not be installed yet.
Refer to the parts list, and select the first resistor, R1. Bend the leads as close to the component body as possible (otherwise, they will not fit well into the holes), and place them into the appropriate holes according to the component outline printed on the circuit board. Be careful to avoid confusing the resistors with the axial inductors which are a bit thicker.

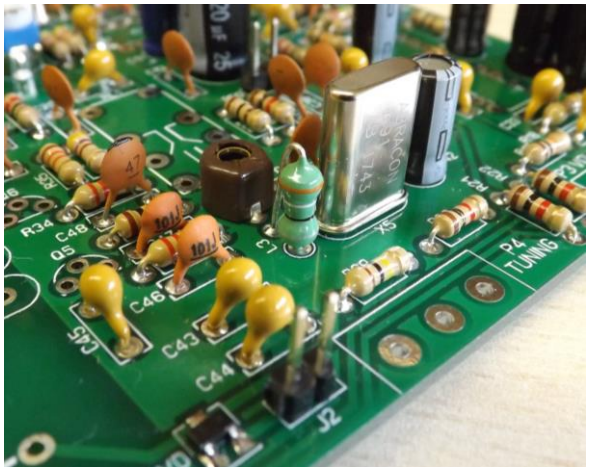
All of the resistors have a light-colored body and a gold band on one end. Inserting the resistor leads into the holes, push down on the body of the component so that it rests flat on the board, hold it in place, and then slightly bend the leads to keep the resistor in place. Then turn the board over and solder the leads to the printed circuit trace. Make sure that the resistor body lies flat on the board so that its leads are as short as possible. Please read the notes about soldering, as poor soldering is the most common cause for a kit failing to work for the first time. After soldering the component leads, cut off the excess length as close to the joint as possible. Mount the next resistor in the parts list in the same manner and continue until all the resistors are mounted.

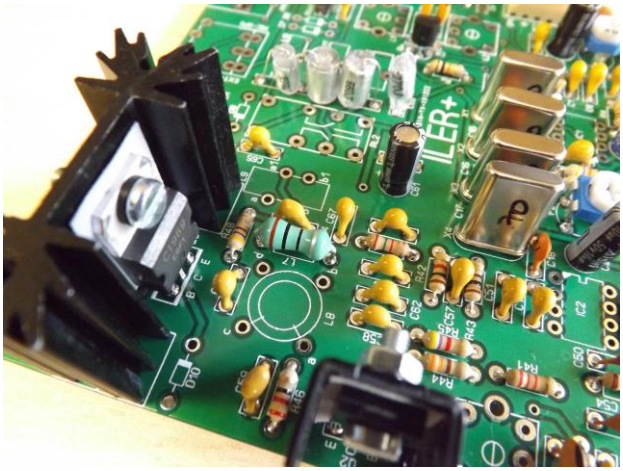
The values which are in decade increments can be easily confused, such as 470, 4K7 and 47K, so be sure to verify the colors before soldering the component in place! If you are in doubt, use a multimeter to check the resistance value.



⇨ Axial Inductors

These components look like thick-bodied resistors and the body is colored blue or green. In their interior there is a small coil wound on a ferrite core. Refer to the parts list to select the correct component for each location. Mount the inductors in their respective locations, as identified on the circuit board, in the same manner as you did with the resistors.
Note: L3 is mounted vertically.



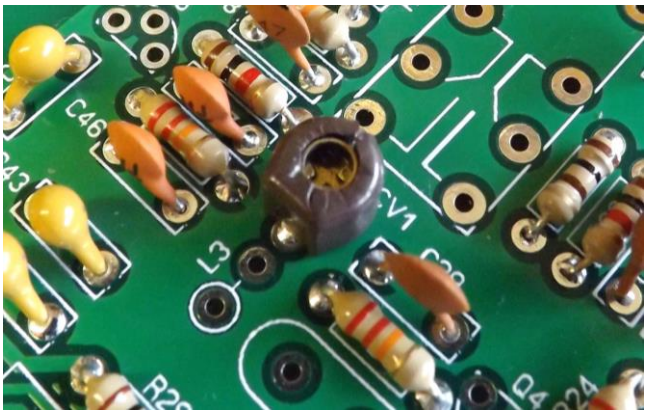


⇨ Diodes

Next mount the diodes, being careful to place them with the correct orientation. There is a dark-colored band on one end of each diode that corresponds to the component outline on the circuit board. D4 through D8 are 1N4148; they are normally orange in color with a black band and they have the type “4148” printed on the body. Note that some diodes are mounted in a vertical position.
D1 and D2 are Zener diodes, similar in size to 1N4148 but are marked 6V2.
D3 is another Zener diode; it is marked 9V1.
D10 is also a Zener diode (thicker than the others); it is marked 47V.
D9 is a 1N4001 or 1N4007 diode; it is mounted vertically as shown in the image.
Diode D11 is a BY255, black, thicker than the others, and it is placed vertically.
The LED is a bi-color type (RX/TX) with three legs. It can be installed during the final phase of the assembly.

⇨ Capacitors

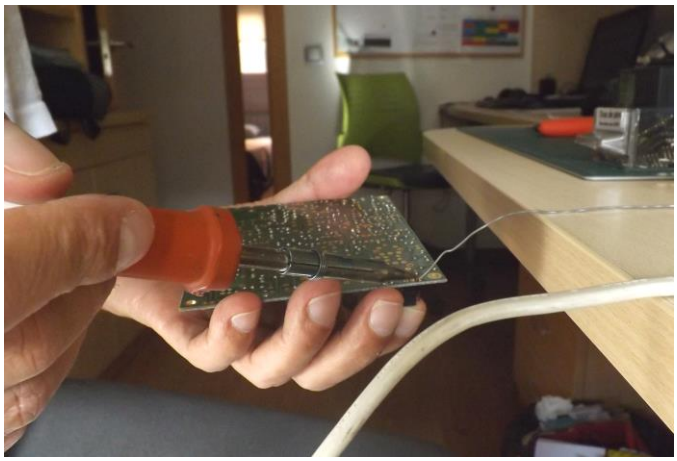
There are ceramic, polystyrene (Styroflex) and electrolytic capacitors. They all have their value printed on the body. Refer to the “identified” column in the parts list.
When you mount them, make sure to leave the leads as short as possible.
C68 through C71 are polystyrene capacitors; these are axial capacitors, but they must be mounted in a vertical position (see image).
The values which are in decade increments can be easily confused, such as 100n and 10n, so be sure to verify the numbers of their value before soldering them in place!
The electrolytic capacitors must be placed with the correct orientation: the LONG LEAD goes in the hole labeled “+” and the SHORT LEAD is "-", indicated by a band containing "-" signs on the side of the capacitor.
CV1 is a trimmer capacitor which is brown in color. It does not have printed numbers. Place it with the rounded edge closest to the relay.

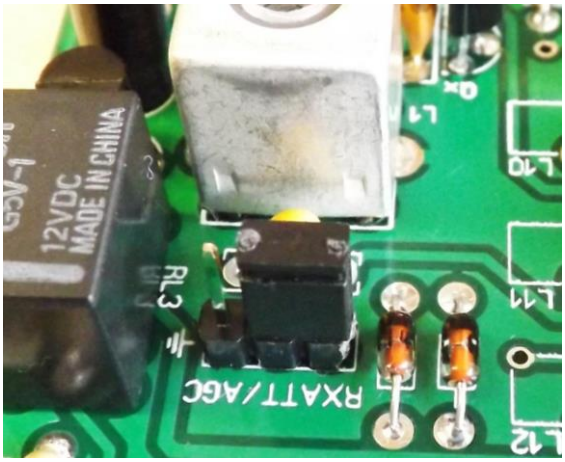


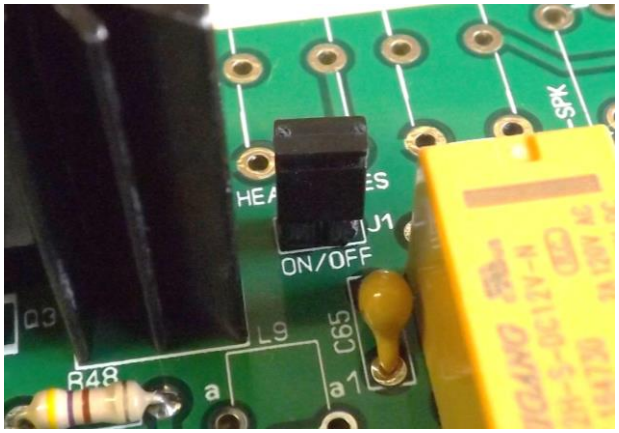
⇨ Pin headers

Place and solder the 5-pin header corresponding to the microphone and speaker.
Place and solder the pin headers “J1”, “J2”, “RXATT / AGC”, “VFO”, “BFO”
Turn the board over and use one hand to insert and hold the header in place, using a “jumper” placed on the header while you solder the pins to avoid burning your fingers. Use your other hand to hold the soldering iron and move the board towards the solder to solder the headers in place. If you have someone available to help you, it will be much easier!

Place jumpers on the terminals:
- “**J1**” (if you do not use an ON/OFF switch)
- “**RXATT/AGC**” (if you do not use the optional external AGC module).







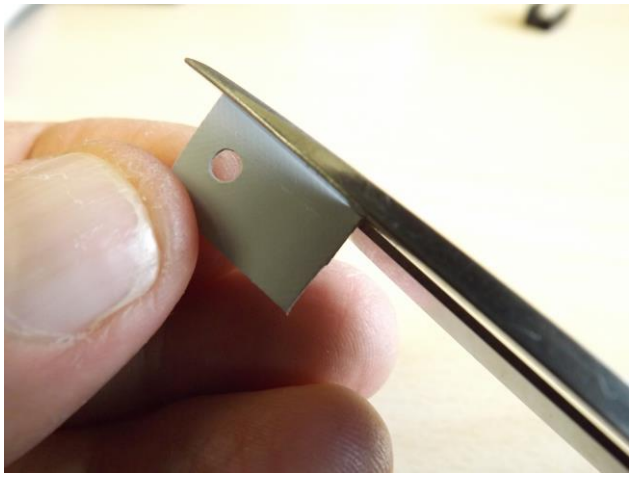
⇨ Transistors

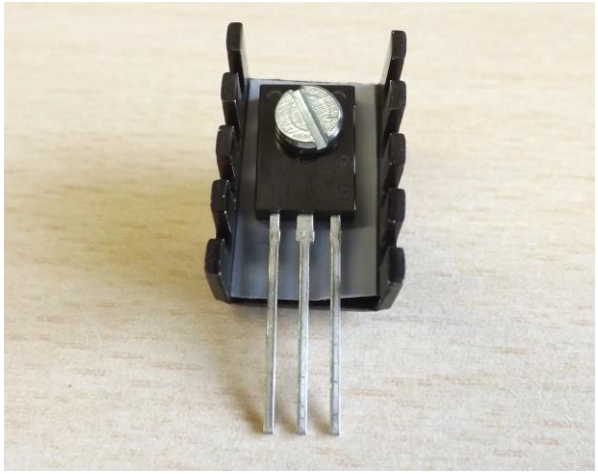
All of the transistors have their type printed on the component body. Place them according to the corresponding component outline printed on the circuit board. Transistors Q4 through Q7 and Qx are all of the type BC547. Q1 is a P2222.

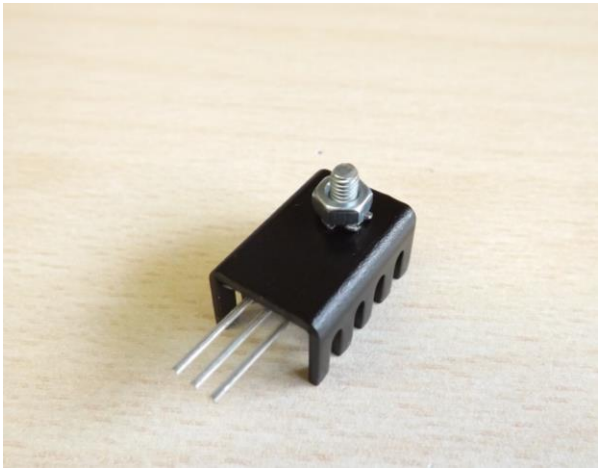
Q2 BD135

Mount Q2 onto the heatsink as shown in the image.

Use a mica insulator sheet that you will find in the kit and trim it 1-2mm so that it seats well within the heatsink.



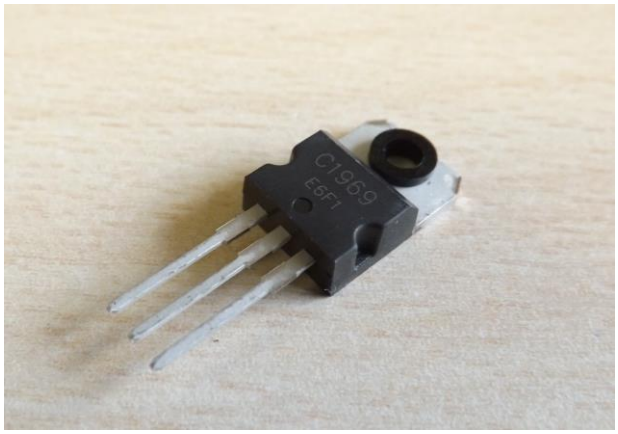


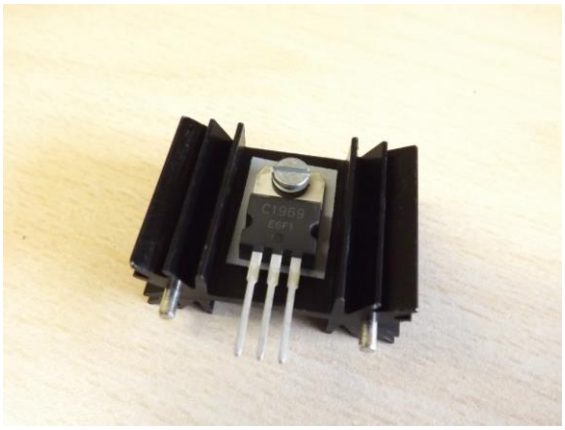


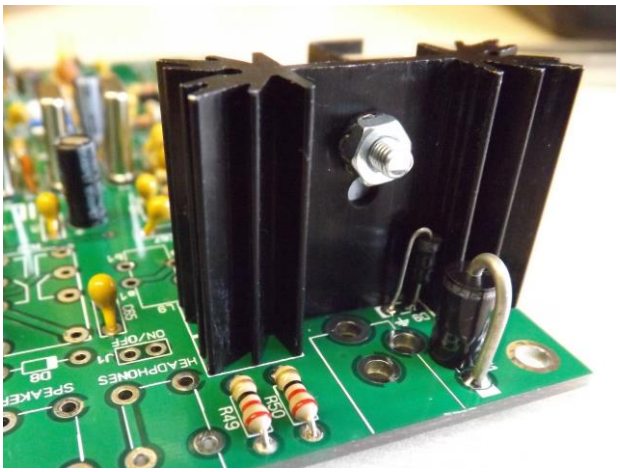
Q3 2SC1969

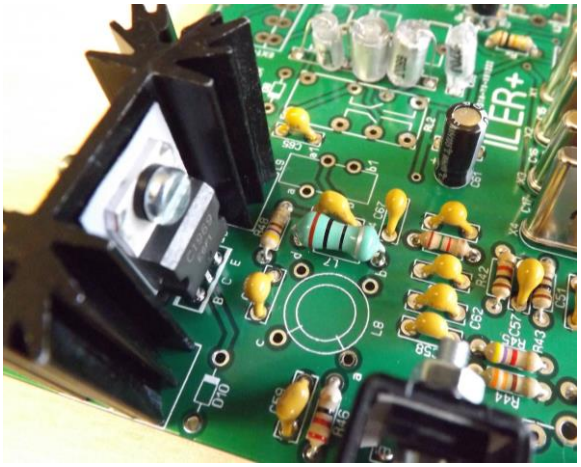
Mount Q3 (TX power amplifier) onto the heatsink as shown in the image. This transistor is placed with a mica insulator sheet and also a heatsink insulator bushing that insulates the screw from the transistor body.

This is an important task; it should be done exactly as shown in the images.









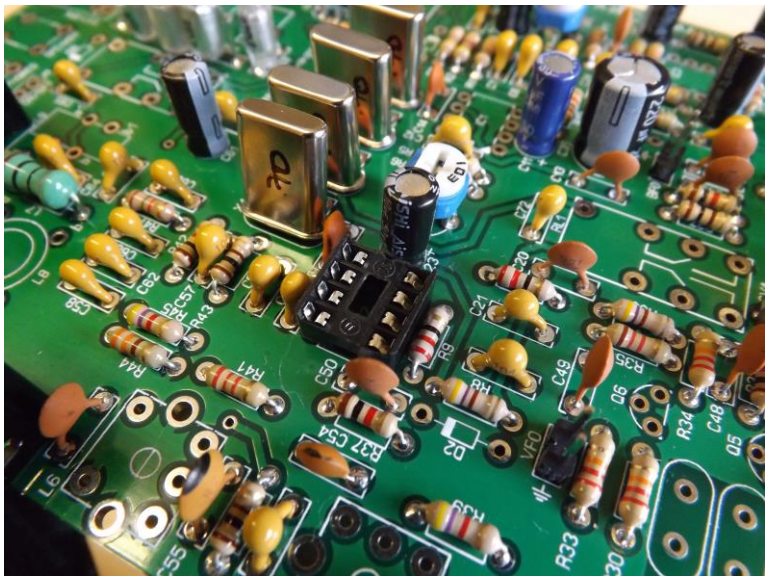
If you plan to work at maximum power and for long periods of time (at base station) it may be advisable to increase the cooling surface. You can add some system to increase the temperature dissipation, for example by an auxiliary metal surface, a mini-fan or other similar system.

⇨ Integrated Circuits

The component outline for the IC on the circuit board has a “U” shaped notch on one end, indicating the end at which pin 1 of the IC is located. There is a similar notch on one end of the sockets. This should be oriented over the "U" notch outline on the circuit board. Finally, pin 1 of the IC is marked with a small dimple or dot; this end of the IC should be oriented towards the notch in the IC socket or the "U" on the component outline.

Mount the sockets for IC1, IC2, IC3 and IC4 in the locations printed on the circuit board. Make sure that the sockets lie flat against the circuit board. Next, insert IC1, IC2, IC3 and IC4 into their respective sockets.

IMPORTANT: Make sure that the IC's are fully inserted into their sockets. A poor contact between the socket and IC can cause malfunction of the kit..



⇨ Crystals

Install X1 through X7.

X1, X2, X3 and X4 are part of the SSB filter, and X5 is the oscillator crystal for the BFO. These crystals have been hand-picked (they have handwritten numbers on them) and have the same resonant frequency, in order to obtain the best filter quality. The pair X6 & X7 are the VXO crystals.

The crystal housing should not touch the board; place them slightly separated from the board, at a distance of 0.5mm.

On ILER-20 v3 the X6 and X7 are 10.240MHz.

⇨ Relays

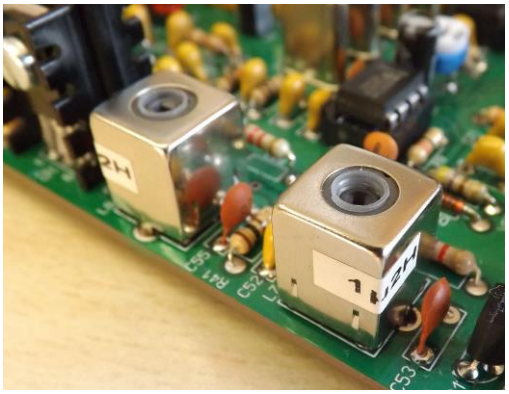
Install relays RL1, RL2 and RL3. They can only be placed in one position.

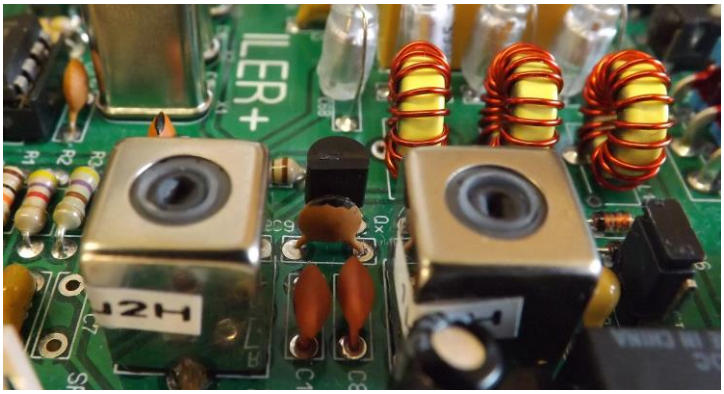
Make sure that the body of the relay lies flat against the circuit board.

⇨ Shielded coils (cans)

L1, L2, L5 and L6 are shielded coils equivalent to Toko KANK3335, marked as 1**u2H or 1R2**. They are RF transformers for the bandpass filters. Make sure that they lie flat against the circuit board.

In order to solder the tabs of the shield, you will need to hold the soldering iron a little longer on the joint.





⇨ LPF Toroids L10, L11 and L12

These are the low-pass filter toroids.

L10 and L12 are identical and are wound with 15 turns. **L11** is wound with 16 turns. They use T37-6 (yellow toroids 9.5mm/0.375in outer diameter).

Cut about 24cm (9.2”) of 0.5mm diameter enameled wire and wind the **L10 and L12** toroids with fifteen (15) turns. Spread the turns evenly around the toroid and wind them tightly so that they follow the contour of the toroid and are as tight against the toroid as possible. The turns should be evenly distributed around the circumference of the toroid.

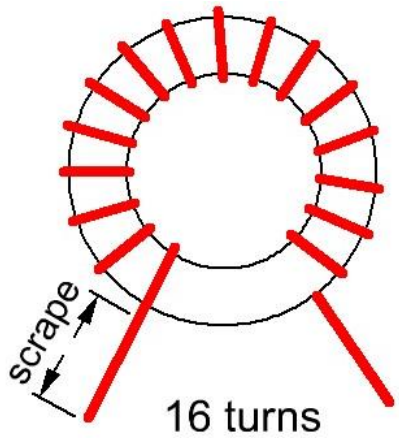
Leave pigtails of about 10mm (0.70”). Scrape off the enamel with a knife from the ends of the wire, in order to solder the toroid onto the board.

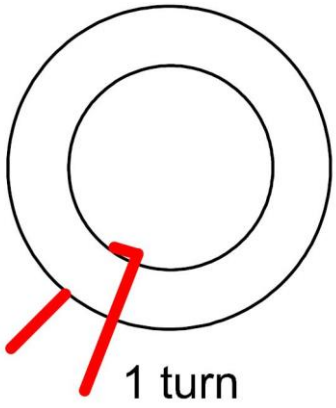
For **L11** cut about 25cm (9.5”) of 0.5mm diameter enameled wire and wind sixteen (16) turns.

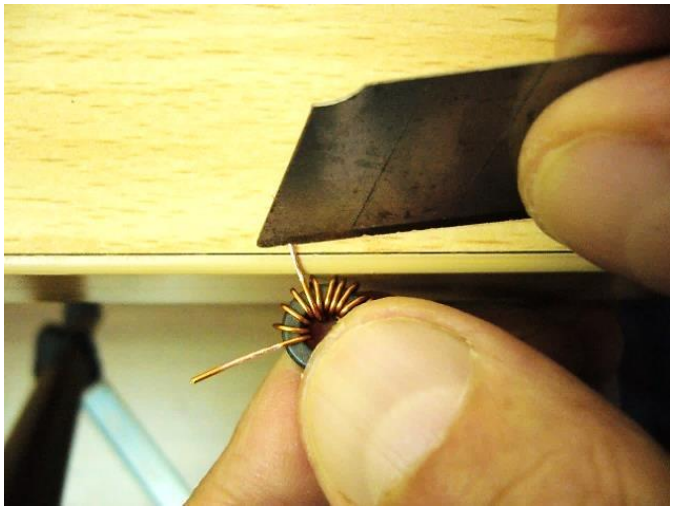
Mount and solder the three toroids in place.

Counting the turns: Count one turn for each pass of the wire through the center of the toroid

Important: wind the toroid exactly as shown in the images. A turn more or less will affect the operation and the output power.







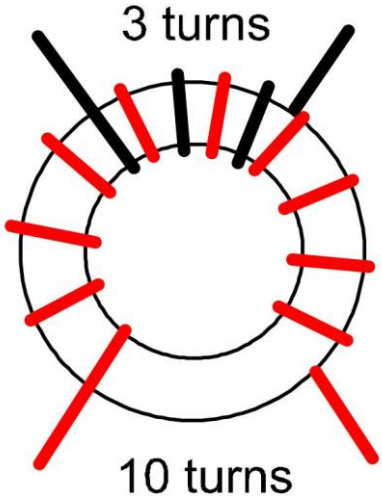
L10 (15 turns) L11 (16 turns) L12 (15 turns)

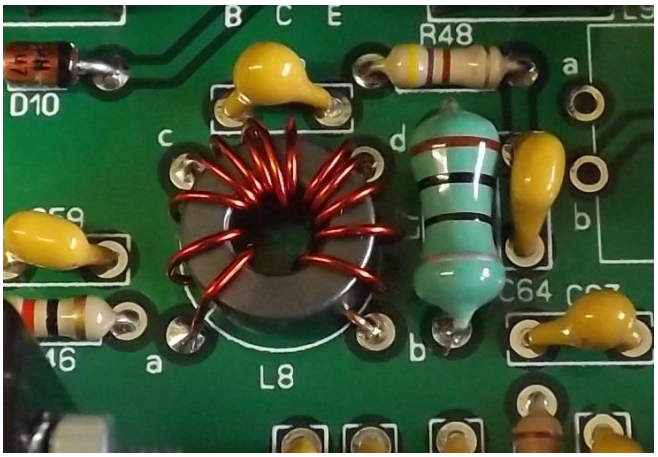
⇨ L8 Toroid Transformer

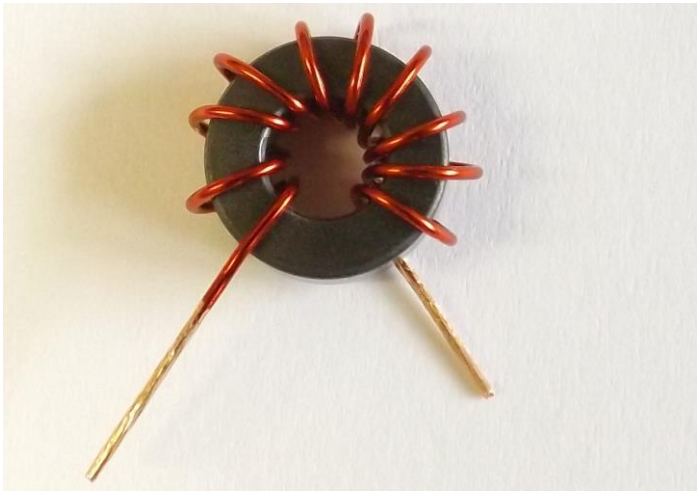
L8 is an impedance matching transformer. An FT37-43 (black toroid 9.5mm/0.375in outer diameter) is used. It has a 10-turn primary and a 3-turn secondary.

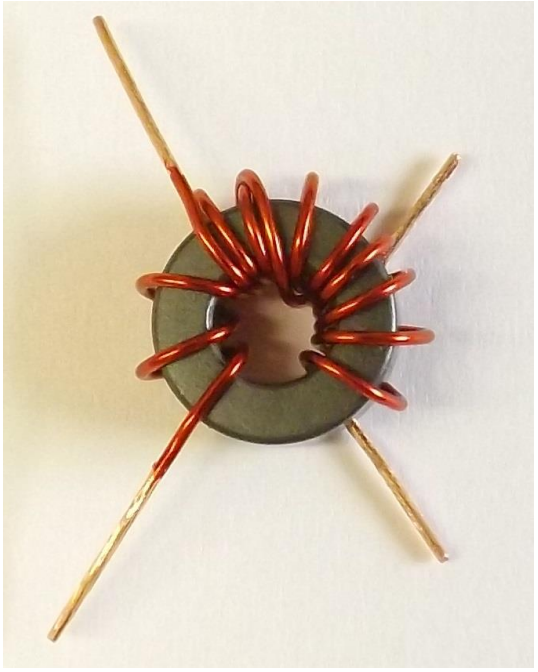
- Take 17cm (7.5”) of 0.5mm diameter enameled wire and wind ten (10) turns on a black FT37-43 toroidal core. Spread the turns evenly around the entire toroid and wind them tightly so that they follow the contour of the toroid and are as tight against the toroid as possible. The turns should be evenly distributed around the circumference of the toroid. Leave pigtails of 10-20mm (0.70”).
- Now take about 8 cm (3.5”) of 0.5mm diameter enameled wire and wind three (3) turns on the other side of the toroid, spacing the turns over the previous winding. Leave pigtails of 10-20mm (0.70”).
- Before inserting them on the circuit board, use a knife or sandpaper to scrape off the enamel from the pigtails of the windings. Solder them in place.
- The 3-turn winding faces towards the output transistor Q3 and the 10-turn winding towards C58 and C66.

Counting the turns: Count one turn for every pass of the wire through the center of the toroid.







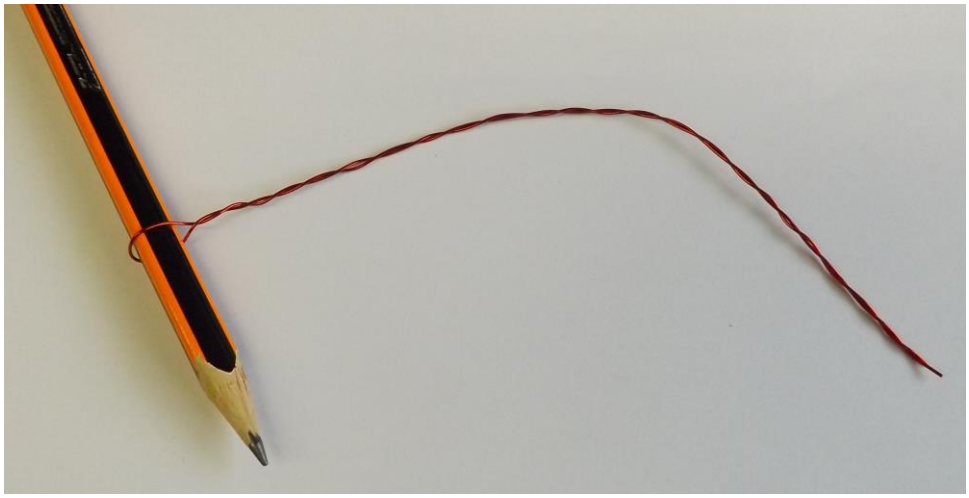


IMPORTANT: Wind the toroid exactly as shown in the images. You must pay attention to number of turns as well as to the direction of the winding.

⇨ L9 Toroid transformer

L9 is an impedance matching transformer with a bifilar winding. An FT37-43 (black toroid with 9.5mm/0.375in outer diameter) is used. It has 8 + 8 turns.

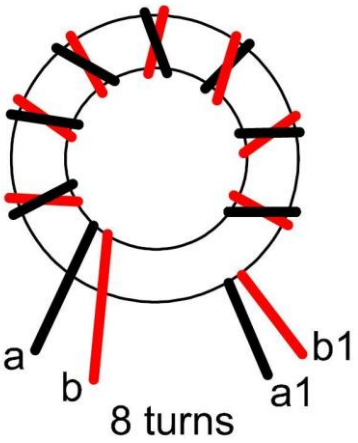
- Cut a 31-32cm (12”) long piece of 0.5mm diameter enameled wire.
- Bend the wire in half.
- Twist it so that there are two twists per cm.

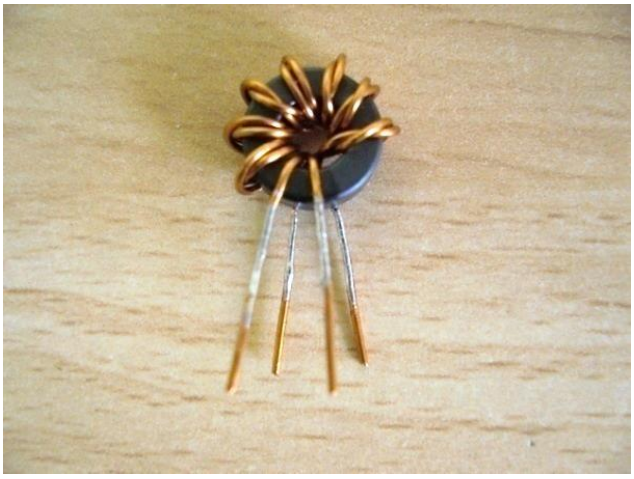


16cm (32cm folded in half)

- Before beginning to wind, leave 15-20mm of wire, measured from the end of the wires to the outer edge of the toroid. Now wind eight (8) turns on the toroid. Remember: Count one turn for each pass of the wire through the center of the toroid.
- Spread the turns evenly around the toroid.

- Cut the ends and separate the two windings.
- Use a sharp knife to scrape the enamel off the ends that will be soldered. The ends of the coils that we have made need to be prepared in this manner before soldering them into the board.
- Using a multimeter in its ohm or continuity function, locate and mark the ends, identifying them as “a” - “a1” and “b” - “b1”.
- Mount the toroid into the appropriate holes as marked on the circuit board.





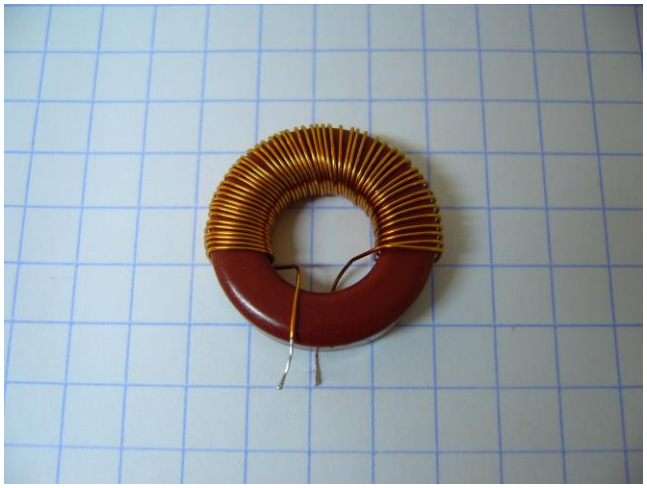
Note: For greater clarity, the drawing shows one black wire and one red wire. In reality, both wires are of the same color. You can mark the "a" -"a1" with a marker pen.

⇨ L4 VXO tuning inductor

L4 should not be mounted yet. It will be installed later in the last section “ADJUSTMENT AND TESTING”.

A T68-2 is used (red toroid with 18mm/0.690in outer diameter).
Cut about 128cm (50”) of 0.3mm enameled wire and wind sixty-one (61) turns on the T68-2 toroid
Leave an extra 1.5-2cm pigtail of wire on each end.

Separate turns



You turn together

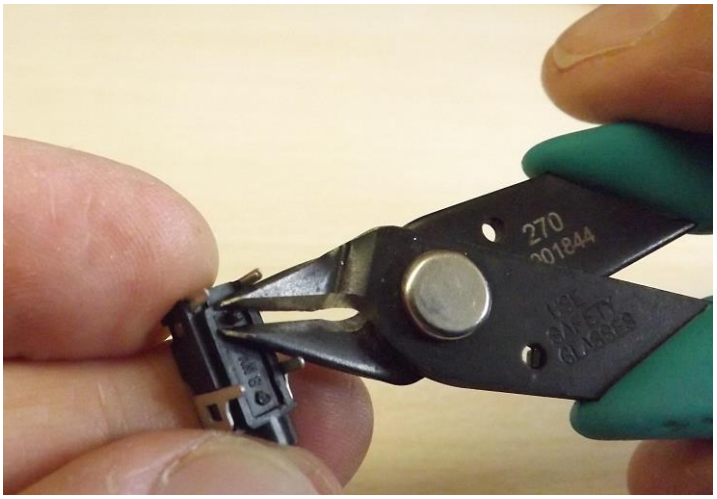
L4 can be wound in two stages. Pass half of the wire through the toroid, wind half of the toroid, and then turn the toroid and wind the other half. If you're not sure how many turns you have wound, you can count them easily looking closely through a magnifying glass. The half-turns that only pass through the inside of the toroid also count as a complete turn.

⇨ P3 volume potentiometer, P4 tuning potentiometer, and external connection jacks

Now mount and solder the P3 volume potentiometer (marked B10K) and the P4 tuning potentiometer (marked B50K) in their respective positions. Mount and solder the antenna and power jacks, and the EXT/SPK switch.

Solder the bi-color LED in position. It should illuminate in green for RX and in red for TX; if it is the contrary, simply turn the LED around (interchanging the two end leads, with the center lead always the common).

Before mounting the external connection jacks, you should cut the protrusions located at the bottom of these jacks; otherwise you will not be able to solder them in the correct position. See the image.



⇨ Terminals "RXATT/AGC" for connecting an RX attenuation potentiometer (optional) or AGC kit "U-AGC/SMETER"

You can connect a 1K linear potentiometer to the RXATT/AGC terminals to adjust to the most appropriate attenuation level at all times. This potentiometer is optional and is not included in the kit. The most recommended option is to connect the "U-AGC/SMETER" kit AGC module (http://www.ea3gcy.com). For connection details see the U-AGC/SMETER kit manual.

If you do not use either of the above options, remember to place a jumper between the active terminals of "RXATT/AGC" (see the "Pin headers" section).

SETTINGS AND TESTS

⇨ First checks

- Adjust P2 (carrier suppression) and P3 (volume potentiometer) to mid-position.
- Adjust P1 (mic gain) to minimum position (counterclockwise).
- Plug a speaker into the "SPK" jack or headphones into the "PHONE" jack.

IMPORTANT: Use a good quality speaker unit. A bad speaker will spoil the quality of the reception.

- DO NOT yet connect a microphone.
- Apply power.
- Measure the voltage at the following main points:

Rx-Tx LED illuminated green (some LED's have the leads reversed; turn it around if it is red in Rx).
9.1V at the cathode of D3 (end of the diode that has the dark colored band).
6.2V at the cathode of D2.

- Turn the volume to maximum; you should hear a light background noise.

If everything is okay, you may continue.
If something is not right, you will need to examine it (see the section, “If your kit does not work after completing assembly").

⇨ Adjustment of the VXO Tuning Inductor L4

The following task is usually quite enjoyable; it is not "plug & play". Take your time and enjoy yourself!
Solder L4 in place as shown in the images. You can compress or spread the turns. Connect a frequency counter to the “VFO” terminal header pins. If the input of your frequency counter is low impedance, insert a 470 ohm resistor or a capacitor of low capacitance (try 22pf or less) in series between the frequency counter and the terminals to reduce interaction with the VXO oscillator.
If you do not have a frequency counter, you can use a good quality SSB or CW receiver that covers the frequency range of the VXO (10.200MHz) and has a digital frequency selection; connect to the receiver antenna input a piece of wire with a small pickup loop and place it close to the *ILER*.

The 4.000MHz IF is added to VXO frequency, for example of 10.225MHz to obtain the operating frequency of 14.255MHz. Another example would be 4.000 IF and VXO 10.200MHz = 14.200MHz.

Spreading or compressing the turns changes the frequency coverage. Compressing the turns increases the inductance, thus increasing the frequency coverage. If the turns are spread, the inductance and thus the frequency coverage decreases. Spreading or compressing the turns very little achieves a variation of a few Khz.

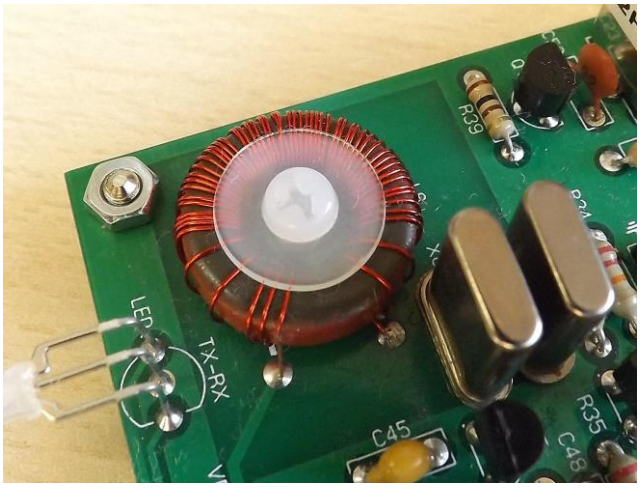
Placing a jumper on **J2** slightly lowers the frequency coverage.

The following illustrative table uses L4 with quite compressed turns.

T68-2= 61 esp.	Minimum		Maximum		
X6-X7 10.240MHz.	MHz	MHz	MHz	MHz	
	VXO	**RF**	**VXO**	**RF**	**Coverage**
J2 no placed	10.180	14.180	10.225	14.225	45kHz
J2 placed	10.145	14.145	10.213	14.213	68kHz

Values are strictly illustrative.
They will be influenced by the spacing of the turns of L4 and component tolerances.

Next, fix L4 to the circuit board with the plastic washer and screw included in the kit. Before fully tightening the screw, you can still compress or spread the turns. See the images.



When you are sure that the frequency coverage of the VXO is suitable to you, you can use a thin layer of nail polish to secure the turns.

L4 should be well secured; this is very important, since vibrations may cause *small changes to the VXO frequency, causing frequency "flutter" in the received and transmitted signals.*

We recommend this number of turns and type of toroid for L4. It works well! However, you can modify and experiment with inductance to try a different coverage. More inductance (more coil turns) will increase coverage but decrease stability and the VXO may even stop oscillating.

In order to obtain reasonable stability, a maximum coverage of 50-60KHz is recommended.

For ease of tuning, you should use a large diameter knob. You can also use a “Vernier" mechanical gear reducer (http://www.ea3gcy.com) or a fine tuning circuit.

If you have the capability of producing graphics, you can create a dial-scale for the front panel to serve as a frequency indicator.

The ILER-20 with the VXO circuit is an ideal transceiver to operate radio by backpack, by bicycle, in SOTA activities etc., since the total power consumption is very low. However, the frequency coverage is small and the stability is not very high.
However, if you wish to cover the entire band with high stability and with frequency readout, we recommend the "*ILER-DDS*", "*ARDU-5351*" or "*ARDU5351 mini*" VFO kits from http://www.ea3gcy.com.

⇨ Adjustment of the BFO/Carrier Oscillator

There are two ways to adjust the BFO oscillator frequency.

Adjustment without instrumentation:
Turn on the transceiver. You can adjust CV1 while listening to an USB signal on the 20 meter band. This is a "two-hand" operation; tune the VXO to obtain the best possible intelligibility, and next adjust CV1 to obtain the best possible audio quality. Repeat these adjustments until obtaining the best possible results.

Instrumentation adjustment (requires a frequency counter):
Turn on the transceiver. Leave it on for about 5 minutes. Connect the frequency counter to the "BFO" terminal header pins. If the input of the frequency counter is low impedance, insert a 470 ohm (or greater) resistor or a small value capacitor (try 22pF or less) between the frequency counter and the terminals to reduce the interaction with the BFO.
Adjust CV1 for a frequency of 3.998.8MHz. You may readjust it slightly later if needed.
The capacitance of the trimmer goes from maximum to minimum in a ½ turn (180 degrees). If you look inside the adjustment hole, you will see that there is an arrow to one side or other of the travel. When the arrow points to the flat part of trimmer, the capacitance is at minimum.
The BFO adjustment is important not only for reception but also for transmission, as it affects the quality of the modulation.

⇨ Adjustment of the RX passband, L1 and L2

For this adjustment you will need an "alignment" tool suitable for this type of coils; if you use a screwdriver, you risk breaking the core of the coil.
With an antenna connected to the transceiver, alternately adjust L1 and L2 until obtaining the maximum noise level in the speaker. Now, try to tune in a stable signal within the band and readjust L1 and L2 alternately until you hear it at the highest possible level.

If you have access to an RF signal generator, begin injecting a signal of about 1uV within the frequency coverage of the receiver and tune it in. Reduce the level of the RF signal generator to the minimum that is still audible with a loudspeaker or headphones, and alternately adjust L1 and L2 until obtaining the maximum reception level.
Once you have finished all of the adjustments and tests, you may make a slight readjustment of the reception if you wish.

Remember: All transmission tests must be done with a 50 ohm load connected to the transmitter output.

⇨ Adjustment of the TX passband, L5 and L6

Connect a power meter with a 50 ohm load to the antenna jack.
I suggest two options for adjusting the transmitter passband:

1) If you have access to an audio generator, set the mic gain (P1) to half range and inject a signal of around 800-1000Hz at about 20mV into the mic input; put the transceiver in transmit mode (PTT pin to "GND") and adjust L5 and L6 alternately until obtaining the maximum power reading on the power meter.

2) If you don't have access to instrumentation, connect an electret condenser microphone to the microphone input, put the transceiver in TX (PTT terminal to "GND") and speak loudly into the microphone, alternately adjusting L5 and L6 until obtaining to the maximum power reading on the power meter.

⇨ Adjustment of Balanced modulator (carrier suppression)

Adjust P1 (mic gain) to minimum (counterclockwise). Adjust P2 to mid-position.
Apply power. Let the transceiver warm up for about 5 minutes.
Now, activate the PTT pin of the mic and monitor the transmitter output with an oscilloscope (with a 50 ohm load connected). Adjust P2 to obtain the minimum level possible of residual carrier signal.
If you don't have access to an oscilloscope, you may listen to the transmitted signal on a SSB/CW receiver; adjust P2 until you hear the least possible amount of carrier signal. Keep in mind that with a receiver so close, you will ALWAYS hear a weak residual signal.

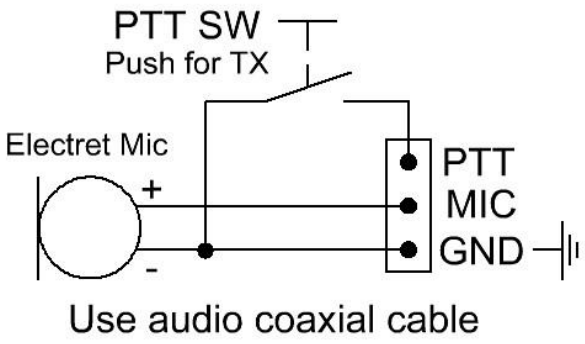
⇨ Adjustment of mic gain P1

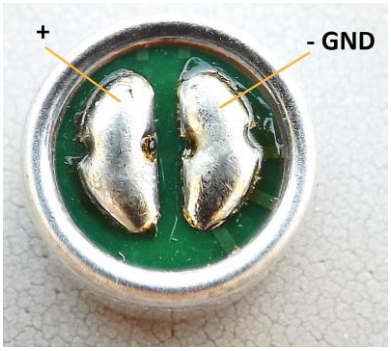
This adjustment is not critical. Speak or whistle into the microphone and adjust P1 to obtain the maximum power level of power on the power meter. P1 can be adjusted just at the point where maximum power is obtained or slightly less. P1 will normally be set to ¾ of its maximum adjustment range. You can even adjust P1 to maximum if the microphone is not very sensitive.
For voices with very high or low tone you can slightly reset the BFO to obtain the best output power level.

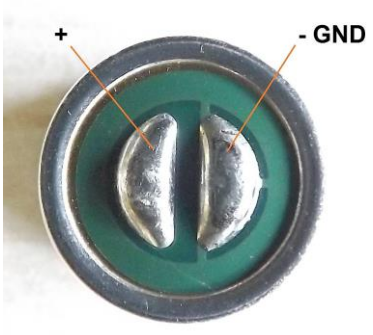
ANNEXES

⇨ Microphone for ILER.

The ILER need a condenser electret microphone (electret capsule included on kit).
This capsule works reasonably well and you can assemble your own microphone.
The wiring is very simple:







Note about electret capsules:
The connections of all capsules have polarity "+" and "-". The "-" it is joined to capsule housing.
You can build your own handheld microphone with the micro electret capsule included in the kit and a pushbutton for PTT:

"Home made" microphone

Multimedia microphones and other microphone capsules.

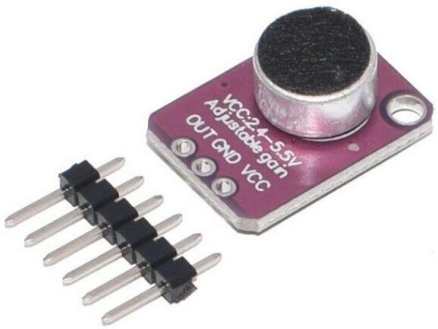
Multimedia microphones are not very sensitive because they are designed for high audio gain systems (sound cards for computers or similar devices). You will have to use some model of processor or pre-amplifier, but be careful not to saturate the transmitter input.

Adjust the microphone signal to the optimum level

If your microphone does not have enough output, you will not be able to get the maximum power from the transmitter, however too much signal will saturate the transmitter input and decrease the output power.

Be careful not to get distortion or feedback in the transmitter.

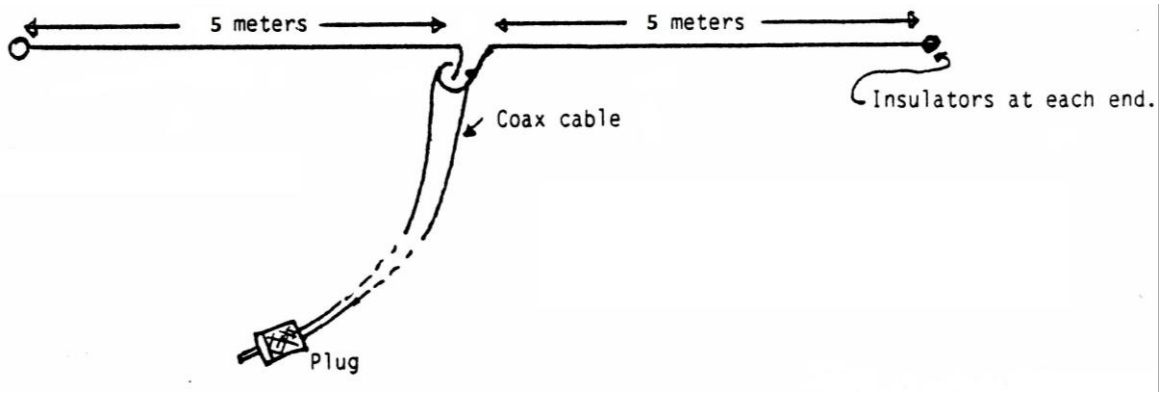
You can also find inexpensive pre-amplified microphone modules online. For example those that incorporate the MAX4466 chip.



NOTE: Install the module in the microphone receptacle. Do not install it inside the equipment, as the mic cable can pick up RF signal and produce feedback in transmission.

⇨ 20 meters Antenna.

To obtain a good performance of the ILER-20 it is essential to use a specific antenna for the 14Mhz band. You can use a ham radio antennas from factory. Or you can build your own dipole antenna for very little money and that will give you very good results. You must build a dipole for each band.



20 m dipole antenna

IF YOUR KIT DOES NOT WORK AFTER COMPLETING ASSEMBLY

Don't worry, it is not uncommon that a kit doesn't work on the first try; stay calm, as in most cases they are minor problems with a simple fix.
Most faults are due to poorly soldered connections or improperly placed components, incorrectly wound toroids, etc.; it is very rare for one of the supplied components to be defective.
Before taking any measurements with test equipment, check all the connections and carefully inspect your soldering, looking for cold joints, short circuits between traces, sockets not making good contact, or components mounted in the wrong place.
If your kit does not work after final assembly, please follow these steps in order:

- Double-check every step in the assembly manual, the solder connections, and correct component placement.
- If you have access to instrumentation, take measurements and follow the signal path of the circuits to diagnose what is happening and why.
- Request another ham experienced with kits or a radio technician to check your work. Someone taking a fresh look may find things that you overlooked.
-If you decide that technical assistance is needed, you are welcome to send an email to ea3gcy@gmail.com. As a last resource, you may send the kit in for repair; however, I will have to charge for any repairs done, although I will try to keep the cost as moderate as possible (see the “FAQ” page of the EA3GCY kits website)

LIMITED WARRANTY

Please read carefully BEFORE building your kit

All electronic components and hardware supplied with the kit are under warranty in case of any manufacturing defect for the period of one year after purchase. The warranty does not include the transmitter final amplifier transistor.

The original purchaser has the option of examining the kit and manual for 10 days. If, within this period, the buyer decides not to build the kit, he/she may return the entire unassembled kit at their own expense for the shipping expenses. The shipping expenses and sales commissions (i.e. bank, EBay, and PayPal commissions) included in the purchase price will not be returned.
Please, BEFORE returning a product, request instructions by email at: ea3gcy@gmail.com

Javier Solans, EA3GCY, warrants this device to function according to the specifications, provided that it is assembled and adjusted as described in this documentation, and used correctly according to all provided instructions.

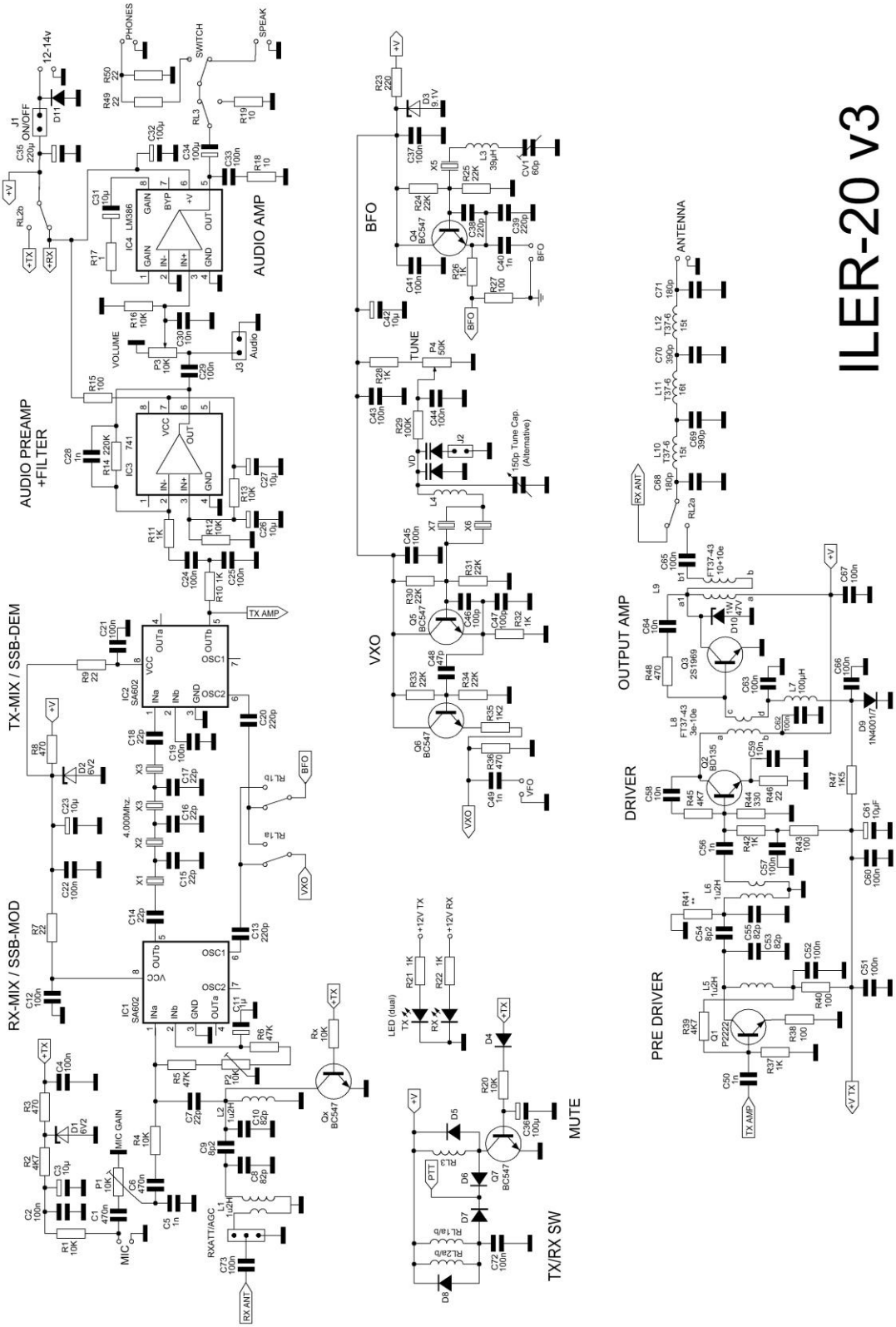
It is your responsibility to follow all the instructions in the manual, to identify all the components correctly, and to use good workmanship and proper tools and instruments in the construction and adjustment of this kit.

REMEMBER: This kit will not work as a commercially manufactured product; however, it can often give similar results. Do not expect great performance, BUT YOU ARE SURE TO HAVE LOTS OF FUN!

If you believe that there is a missing kit component, please do a thorough inventory of all parts using the parts list in the manual. Check all bags, envelopes and boxes carefully. If needed, you may email me and I will replace any component that you are missing. Even if you can find the exact part locally, please let me know so that we are aware of the problem to help other customers.
I can also supply any part that you have lost, damaged or broken accidently.
If you find any errors in this manual or would like to make a comment, please do not hesitate to contact me at ea3gcy@gmail.com

THANK YOU for building the ILER-40 v3 SSB Transceiver kit.
Enjoy QRP!
73 Javier Solans, EA3GCY

SCHEMATIC


ILER-20 v3
AUDIO AMP
AUDIO PREAMP +FILTER
TX-MIX / SSB-DEM
RX-MIX / SSB-MOD
BFO
VXO
OUTPUT AMP
DRIVER
PRE DRIVER
TX/RX SW
MUTE
ANTENNA
VOLUME
TUNE
PHONES
SWITCH
SPEAK
12-14v
Audio
MIC
MIC GAIN
RXATT/AGC
4.000Mhz.
150p Tune Cap. (Alternative)
LED (dual)
+12V TX
+12V RX

WIRING AND CONNECTIONS

- The ILER-20 v3 only requires wiring of the microphone, PTT and speaker internal to the microphone (if using a speaker-mic) or a speaker installed inside the transceiver cabinet.
- The ILER-20 v3 circuit board incorporates the power, antenna, headphone, and external speaker jacks, and the external speaker-mic/speaker switch.
- Optionally, you can connect an ON/OFF switch instead of jumper J1.

It is highly recommended that suits a metal box for all items that are installed on the board. If you use a plastic box, then shield with conductive paint or conductive tape (aluminum or copper may be suitable).

The ILER-20 v3 is protected against possible polarity reversal faults by means of diode D11
If your power supply is short-circuit protected or is equipped with a fuse at the output, perfect; if not, build or purchase a cable with a built-in series 2.5 or 3A fuse.
If you make a mistake with the polarity, then the fuse will blow.