MFT-20

My First Transceiver

20 Meters DSB Transceiver Kit

Assembly manual

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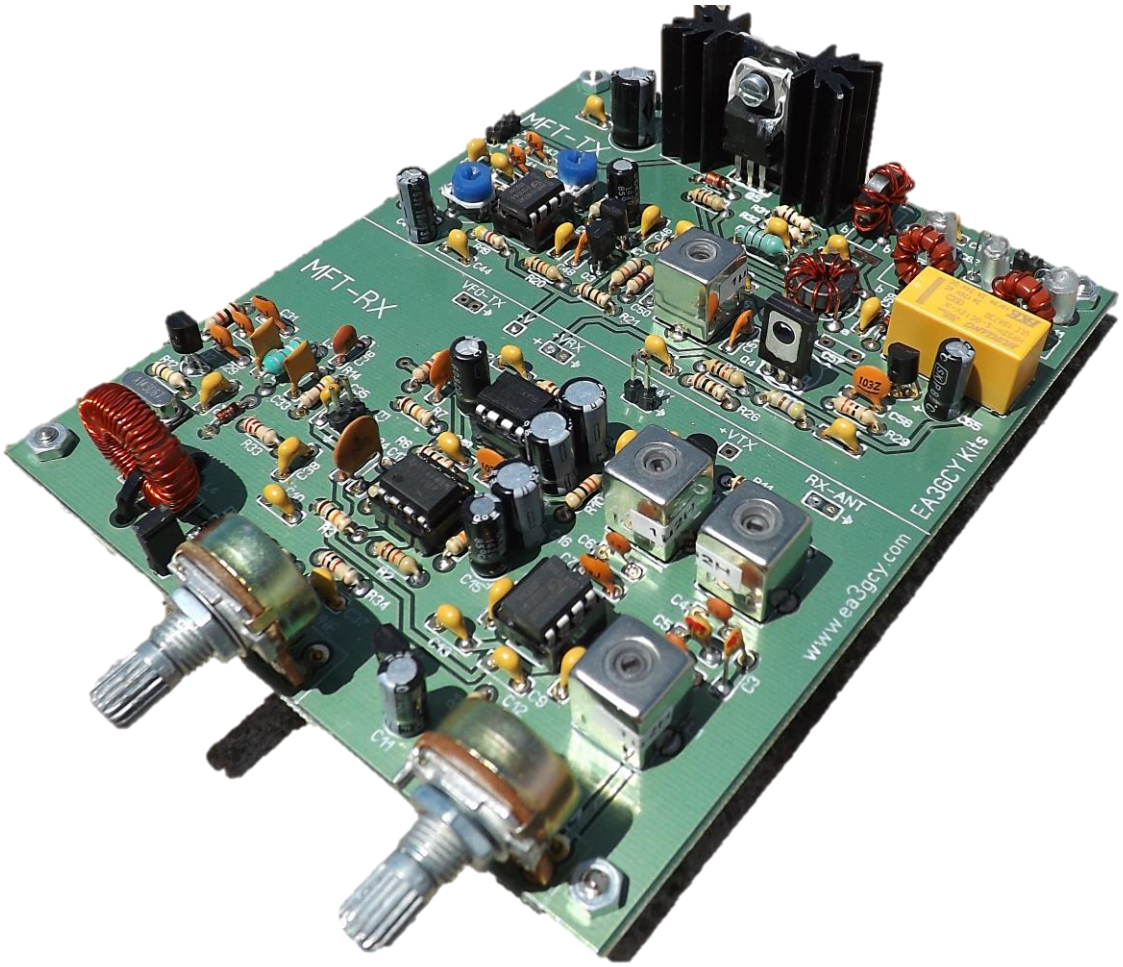


Thanks for constructing the MFT-20 DSB Transceiver kit

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

INTRODUCTION

MFT-20

The MFT-20 “**M**y **F**irst **T**ransceiver” is a simple, low-cost DSB (double sideband) transceiver similar to the famous “Beach-40”, “Micro-40” by VK3YE, “Wee Willy” by VA3IUL, etc. However, the MFT has improved both the receive and transmit characteristics, and its kit assembly puts the project within the reach of radio circuit builders of any level.

The MFT-20 is a transceiver designed especially for new builders, for educational use in schools and for club building projects and the like. However, it is also a very attractive assembly project for experienced amateurs who like low power and want to get on the air with "minimalist" equipment.

The printed circuit board (PCB) is over-sized for easy location and placement of the components. The receiver (MFT-RX) can be assembled and put in operation independently of the transmitter, which allows neophytes to assemble and use the receiver before beginning to work on the transmitter (MFT-TX). The transmitter cannot operate without the receiver, since the local oscillator is built into the receiver.

The kit can be assembled on a Saturday morning, with time left in the afternoon to go out to the field with it and make a few QRP contacts.

The MFT-20 incorporates a DC (direct conversion) receiver with a 3-stage front-end passband filter, followed by a balanced mixer, an audio preamplifier and filter using an operational amplifier, and an output amplifier for driving a loudspeaker. The local oscillator is based on standard low-cost quartz crystal of 14.270MHz with which it can be tuned 50KHz or more.

The DSB (double sideband) transmitter uses a DSB generator with input from an economical electret condenser microphone and three stages of amplification which produce >3W to the antenna.

The simple circuits used make it is possible to enjoy amazing QRP contacts.

The optional **“ILER-DDS”** kit makes it possible to cover the entire band.

The transmitter has a robust design to withstand and work hard in the field!

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

SPECIFICATIONS

GENERAL:

Frequency coverage: High stability quartz Crystal oscillator 14.270MHz which can over 50KHz or more.
Frequency control: Varactor diode.
Antenna: 50 ohms.
Power supply: 12-14VDC, 30mA in receive (without signal), about 1000mA in transmit.
Components: 36 resistors, 2 variable resistors, 67 capacitors, 2 potentiometers (RX-gain/volume and Tuning), 5 IC's, 5 transistors, 2 inductors-chokes, 6 RF transformers, 6 diodes, 1 quartz crystal.
Front panel controls: Tuning and RX gain.
External connections: mic/ptt, speaker jack, antenna, DC input.
Circuit board dimensions: 110x130 mm.

TRANSMITTER:

RF output: 3W@12V, 3,5W@13.8V.
Second harmonic output: -42dB below the fundamental frequency.
Other spurious signals: all signals -50dB or better below the fundamental frequency.
Carrier suppression: better than -20dB.
T/R switching: Relay.

Microphone type: electret.

RECEIVER:
Type: DC Direct Conversion.
Front end: Triple tuned circuit.
Sensitivity: 1.5uV minimum discernible signal.
Audio Preamp and Filter
Audio output: 250mW @ 8 Ohms.

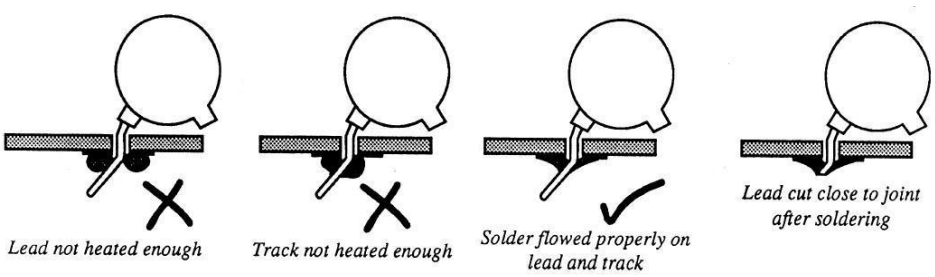
PLEASE READ ALL OF THE ASSEMBLY INSTRUCTIONS COMPLETELY AT LEAST ONCE BEFORE BEGINNING.

TIPS FOR FIRST TIME BUILDERS

Tools required:
- A 30w soldering iron with fine tip, 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, oscilloscope (desirable but not essential), frequency counter or HF receiver, RF power meter, dummy load: 5W - 50 Ohms.

Soldering:
There are two important things which need to be done to insure successful operation of a kit. The first is to put the component into the proper place on the circuit board; the second is good soldering.



To solder properly, you must use a high-quality solder for electronics use and the correct type of iron. Use a small soldering iron with a fine, pointed tip. The soldering iron should be about 30 watts (if it is not thermostatically controlled). Use only high-quality electronic type solder. NEVER use any 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 lead and trace and wait about two seconds or so until the solder flows between the terminal and the trace to form a good joint. Now remove the soldering iron. The soldering iron should have been in contact with the work piece for a total time of about 4-5 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 black 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.

Coils and transformers:

You may find it convenient to wind and prepare all the coils and transformers 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 and instructions in the manual will illustrate and accompany you in the process.

PARTS LIST SORTED BY VALUE/QUANTITY

Resistor list				
Qty	Value	Checked	Ref.	Identified
2	1		R31, R32	brown-black-gold
1	10		R9	brown-black-black
3	22		R1, R10, R29	red-red-black
4	100		R6,R21, R23, R26	brown-black-brown
1	220		R33	red-red-brown
3	470		R14, R15, R28	yellow-violet-brown
6	1K		R2, R13, R20, R25, R30, R34	brown-black-red
3	4K7		R8, R19, R24	yellow-violet-red
1	6K8		R22	blue-gray-red
5	10K		R3, R4, R7, R11, R18	brown-black-orange
2	56K		R16, R17	green-blue-orange
3	100K		R5, R12, R35	brown-black-yellow
2	10K		P3, P4 Trimmer 10K (103)	103 trimmer
1	1K		P1 RX-Gain Potentiometer	B 1K lin.
1	50K		P2 Tune Potentiometer	B 50K lin.

Capacitor list				
Qty	Value	Checked	Ref.	Identified
2	470n		C39,C40	474 or 0.47
27	100n		C1 C8 C9 C10 C12 C13 C14 C18 C22 C25 C26 C28 C37 C38 C44 C46 C47 C49 C52 C53 C54 C58 C59 C60 C61 C62 C67	104 or 0.1
3	10n		C19, C21, C56	103 or 0.01
1	2n2		C17	222, 222K, 0.0022
5	1n		C35, C41, C43, C48, C51	102 or 0.001
1	470p		470p Polystyrene, C64	470
2	220p		220p Polystyrene, C63, C65	220
2	100p		C29, C30	101 or 100
6	82p		C2, C4, C6, C34, C36, C50	82P or 82P
2	68p		C32, C33	68P or 82P
2	22p		C7, C316	22P, 22pK or 22J
2	8p2		C3, C5	8P2 or 8.2
1	220uf		C66 (elec.)	220uf 25v or 35V
2	100uf		C23, C24 (elec.)	100uf 25V or 35V
7	10uf		C11, C16, C15, C20, C42, C45, C55 (elec.)	10uf 25V 35V or 63V

Semiconductor list				
Qty	Type	Checked	Ref.	Identified
Transistors				
2	BC547		Q1, Q2	BC547
1	P2222		Q3	2222
1	BD135		Q4	BD135
1	2SC2078		Q5 (heatsink + washer + mica spacer)	C2078
Integrated circuits				
1	LM741		IC2	LM741CN or UA741
2	SA/NE602		IC1, IC6	SA602AN or NE602AN
1	LM386		IC3	LM386N-1
2	78L06		IC4, IC7	MC78L06
1	78L08		IC8	MC78L08
Diodes				
1	1N4148		D1	4148
1	1N4001(7)		D2	1N4001 or 1N4007
1	47V		D3 Zener 47V 1W	BZX85C47 or Z47
1	9V1		D4 Zener 9V1 0.5W	9V1
1	SVC236		Varactor diode SMD	Z V

Inductor/RF Transformer list/Crystal/Relay list				
Qty	Value	Checked	Ref.	Identified
1	100uH		L8 Axial inductor	brown, black, brown
1	3,9uH		L5 Axial inductor	orange-white-gold
2	T37-2		L10, L11 LPF toroids	9.5 mm diam red
1	T68-2		L4 Toroid. Tuning inductor	17 mm diam red
4	1u2H (3335)		L1, L2, L3, L6 shielded coils 1u2H	1u2H
2	FT37-43		L7 toroid 10t - 3t ; L9 toroid 8t+8t	9.5 mm diam. Black
1	14.270MHz		X1	14270
-	14.270MHz		X2	14270
1	Relays		RL1	-

Hardware				
Qty	Value	Checked	Ref.	Identified
5	M3 nuts		hex nuts M3	-
4	spacers		5mm hexagonal spacer for M3 screw	-
4	M3x5 screw		5mm M3 screw	-
1	M3x10 screw		10mm M3 screw	-
1	M3 washer		M3 lock washer	-
21	pins		MIC(3), 12-14V(2), ANT(2), SPEAK(2), EXT-VFO(2), J1(2) *VFO-TX (2) +V (1), +VRX (2), +VTX (1), RX-ANT (2)	-
1	jumper		jumper for J1	-
4	IC socket		IC's socket 8 pin	-
1	Heatsink		RD756 Heatsink for Q5 (output transistor)	-
110cms	Copper wire 0,5		110 cms enameled copper wire 0,5mm for L7, L9, L10 and L11	-
95cms	Copper wire 0,3		95 cms enameled copper wire 0,3mm for L4	
1	Electret mic		Electret Microphone capsule	
	MFT PCB		110mm x 130mm MFT PCB	-

* Pins listed in small print are only placed if the receiver is built independently (without the transmitter).

LIST OF INDIVIDUAL COMPONENTS

The shaded rows are the receiver parts; the other rows are the components of the transmitter. The receiving block contains the VFO and can operate independently even if the transmitter is not built; however, the transmitter needs the receiver to work.

Resistors						
Checked		Ref.	Value	Ident./Comment	Circuit section	Located
		R1	22	red-red-black	RX mix	L-9/8
		R2	1K	brown-black-red	Audio filter & preamp	K-6
		R3	10K	brown-black-orange	Audio filter & preamp	K-5
		R4	10K	brown-black-orange	Audio filter & preamp	J/K-7
		R5	100K	brown-black-yellow	Audio filter & preamp	J/K-5
		R6	100	brown-black-brown	Audio filter & preamp	J-5/6
		R7	10K	brown-black-orange	Audio Amp	I-5
		R8	4K7	yellow-violet-red	Audio Amp	H-4
		R9	10	brown-black-black	Audio Amp	H-6
		R10	22	red-red-black	Audio Amp	I-7/8
		R11	10K	brown-black-orange	Rx mute	G/H-9
		R12	100K	brown-black-yellow	VFO	K-1
		R13	1K	brown-black-red	VFO	J-1
		R14	470	yellow-violet-brown	VFO	J-3
		R15	470	yellow-violet-brown	DSB Generator	E-2
		R16	56K	green-blue-orange	DSB Generator	D-2
		R17	56K	green-blue-orange	DSB Generator	D-4
		R18	10K	brown-black-red	Electret mic. Bias	F-1
		R19	4K7	yellow-violet-red	Electret mic. Bias	F-3
		R20	1K	brown-black-red	Pre Driver	F-4
		R21	100	brown-black-brown	Pre Driver	F-5
		R22	6K8	blue-grey-red	Pre Driver	E-5
		R23	100	brown-black-brown	Pre Driver	D-5
		R24	4K7	yellow-violet-red	Pre Driver	E-5
		R25	1K	brown-black-red	Driver	F-8
		R26	100	brown-black-brown	Driver	F-8
		R27	No used	---	Driver	D-8
		R28	470	yellow-violet-brown	Driver	F-9
		R29	22	red-red-black	Driver	E-10
		R30	1K	brown-black-red	Output Amp Bias	C-5
		R31	1	brown-black-gold	Output Amp	B-6/7
		R32	1	brown-black-gold	Output Amp	C-6/7
		R33	220	red-red-brown	VFO	K3
		R34	1K	brown-black-red	VFO	L6
		R35	100K	brown-black-yellow	VFO	L5
		P1	1K	RX-GAIN Potentiometer	RX Antenna Input	M-10
		P2	50K	TUNE Potentiometer	VFO	M-6
		P3	10K	103 trimmer	Mic Gain	E-2
		P4	10K	103 trimmer	DSB balance	D-3

Capacitors						
Checked		Ref.	Value	Ident./Comment	Circuit section	Located
		C1	100n	104 or 0.1	RX antenna Input	H-10
		C2	82p	82 or 82J	Rx passband	J-10
		C3	8p2	8p2 or 8.2p	Rx passband	J-11
		C4	82p	82 or 82J	Rx passband	J-10
		C5	8p2	8p2 or 8.2p	Rx passband	J-10

		C6	82p	82 or 82J	Rx passband	J-8/9
		C7	22p	22 or 22J	Rx passband	J-8/9
		C8	100n	104 or 0.1	Rx Mix	K-8
		C9	100n	104 or 0.1	Rx Mix	L-8/9
		C10	100n	104 or 0.1	Rx Mix	L-4/5
		C11	10uF	10uF electrolytic	Rx Mix	M-8
		C12	100n	104 or 0.1	Rx Mix	L-9
		C13	100n	104 or 0.1	Audio filter & preamp	L-8
		C14	100n	104 or 0.1	Audio filter & preamp	K-9
		C15	10uF	10uF electrolytic	Audio filter & preamp	K-7
		C16	10uF	10uF electrolytic	Audio filter & preamp	J-7
		C17	2n2	222 or 222K or .0022	Audio filter & preamp	J/K-5
		C18	100n	104 or 0.1	Audio filter & preamp	J-5/6
		C19	10n	103 or 0.01	Audio Amp	J-6/7
		C20	10uF	10uF electrolytic	Audio Amp	I-5
		C21	10n	103 or 0.01	Audio Amp	I-5
		C22	100n	104 or 0.1	Audio Amp	H-5
		C23	100uF	100uF electrolytic	Audio Amp	H-7
		C24	100uF	100uF electrolytic	Audio Amp	I-7
		C25	100n	104 or 0.1	Audio Amp	H-8
		C26	100n	104 or 0.1	Audio Amp	H-7/8
		C27	No used	---	---	M/L-4
		C28	100n	104 or 0.1	VFO	K-2
		C29	100p	101 or 100	VFO	J-1/2
		C30	100p	101 or 100	VFO	J-1/2
		C31	22p	22 or 22J	VFO	I-1/2
		C32	68p	68P or 68J	VFO	J-2
		C33	68p	68P or 68J	VFO	J-3
		C34	82p	82P, 82pK or 82J	VFO out	J/K-5
		C35	1n	102 or 0.001	VFO	J-3
		C36	82p	82P, 82pK or 82J	VFO out	I-4
		C37	100n	104 or 0.1	VFO	K-2/3
		C38	100n	104 or 0.1	VFO	K-4
		C39	470n	474 or 470K	Mic Input	D-1
		C40	470n	474 or 470K	Mic Input	D-2
		C41	1n	102 or 0.001	Mic Input	D-2
		C42	10uF	10uF electrolytic	DSB Generator	D-4
		C43	1n	102 or 0.001	Electret mic bias	C-2
		C44	100n	104 or 0.1	Electret mic bias	F-2/3
		C45	10uF	10uF electrolytic	Electret mic bias	F-2
		C46	100n	104 or 0.1	DSB Generator	D-5
		C47	100n	104 or 0.1	DSB Generator	E-4
		C48	1n	102 or 0.001	Pre Driver Input	E-4
		C49	100n	104 or 0.1	Pre Driver	D-5/6
		C50	82p	82 or 82p or 82J	Pre Driver passband	E-6
		C51	1n	102 or 0.001	Driver Input	E-7
		C52	100n	104 or 0.1	Pre Driver	F-7
		C53	100n	104 or 0.1	Pre Driver	D-6/7
		C54	100n	104 or 0.1	Pre Driver	F-10
		C55	10uF	10uF electrolytic	Output Amp Bias	E-10/11
		C56	10n	103 or 0.01	Driver	E-9/10
		C57	No used	---	Driver	D-9
		C58	100n	104 or 0.1	Output Amp	C-7/8
		C59	100n	104 or 0.1	Driver	C/D-9
		C60	100n	104 or 0.1	Output Amp Bias	C-6/7
		C61	100n	104 or 0.1	Output Amp Bias	A-8/9
		C62	100n	104 or 0.1	Output Amp	A-8/9
		C63	220p poly	220	LPF	B-8/9
		C64	470p poly	470	LPF	B-10
		C65	220p poly	220	LPF	B-11
		C66	220uF	220uF electrolytic	Relay Tx/Rx switch	B-3
		C67	100n	104 or 0.1	Relay Tx/Rx switch	B-2

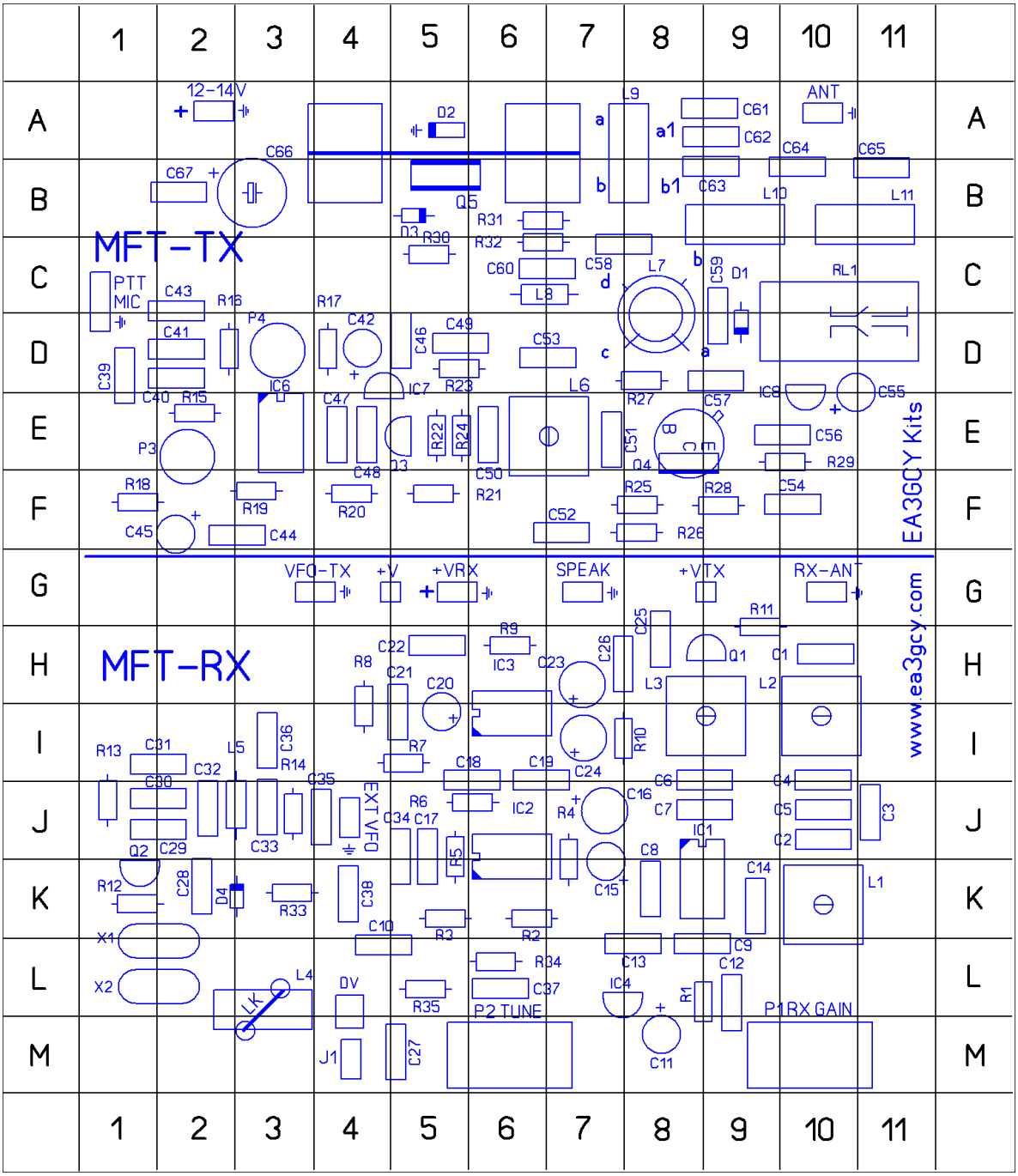
Crystals						
Checked		Ref.	Frequency	Ident./Comment	Circuit section	Located
		X1	14.328 quartz crystal		VFO	L-1
		X2	14.328 quartz crystal		VFO	L-1

Semiconductors						
Checked		Ref.	Type	Ident./Comment	Circuit section	Located
		Transistors				
		Q1	BC547	BC547	Rx Mute	H-8/9
		Q2	BC547	BC547	VFO	K-1
		Q3	P2222	P2222	Pre Diver	E-5
		Q4	BD135	BD135	Driver	E-8
		Q5	2SC2078	2SC2078	Output Amp	B-5
		IC's				
		IC1	SA/NE602	SA602AN or NE602AN	Rx Mix	K-8/9
		IC2	LM741	LM741CN or UA741	Audio filter & preamp	J/K-6
		IC3	LM386	LM386N-1	Audio Amp	I-6
		IC4	78L06	MC78L06	Rx Mix 6V supply	L-7/8
		IC6	SA/NE602	SA602AN or NE602AN	DSB Generator	E-3
		IC7	78L06	MC78L06	DSB Generator 6V	D-4/5
		IC8	78L08	MC78L08	TX Bias supply	E-10

		Diodes				
		D1	1N4148	4148	Rx/Tx Relay switch	D-9
		D2	1N4007 or 4001	1N4007(1)	Output Amp Bias	A-5
		D3	Zener 47V 1W	BZX85C47 or Z47	Output Amp protect	B-5
		D4	Zener 9V1 0,5W	9V1	VFO	K-3
		DV	SVC236	Varactor diode	VFO	M-3

Inductors/RF Transformers						
Checked		Ref.	Value/Type	Ident./Comment	Circuit section	Located
		L1	KANK3335 (1u2H)	K3335 or 1u2H	Rx Mix	K-10
		L2	KANK3335 (1u2H)	K3335 or 1u2H	Rx Mix	I-10
		L3	KANK3335 (1u2H)	K3335 or 1u2H	Rx Mix	I-8/9
		L4	T68-2	Turns = Text	VFO	L3
		L5	3,9uH axial inductor	orange-white-gold	VFO	J-2/3
		L6	KANK3335 (1u2H)	K3335 or 1u2H	TX Pre driver	E-6/7
		L7	FT37-43	toroid 10t - 3t see text	Driver	C/D-8
		L8	100uH axial inductor	brown-black-brown	Output Amp Bias	C-6/7
		L9	FT37-43	toroid 8+8 see text	Output Amp	A/B-7/8
		L10	T37-2	Turns = see text	LPF	B-9
		L11	T37-2	Turns = see text	LPF	B-10/11

143-QUADRANT COMPONENT LAYOUT MAP



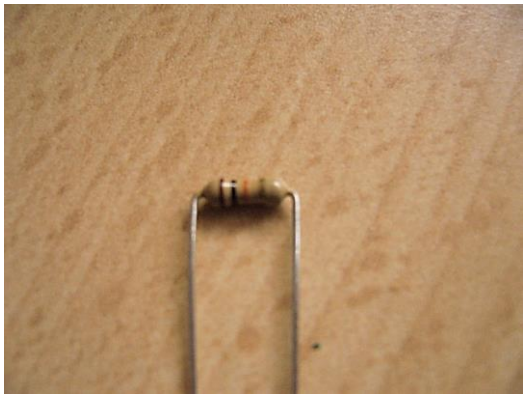
ASSEMBLY

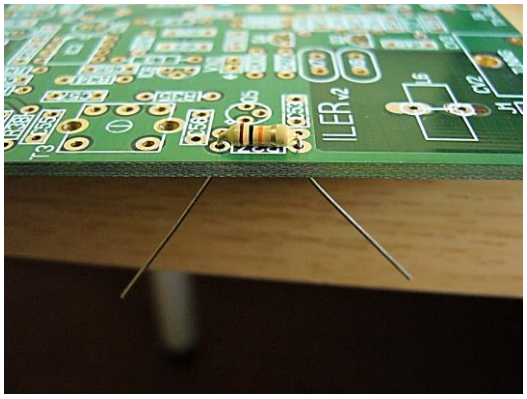
You can use the “individual parts list” or the “value/quantity parts list.” Using the “value/quantity parts list” is the quickest way to mount components since all the circuit board components of the same value or type can be placed one after the other. However, you will need the “individual parts list” 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 143-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 is there and ready for assembly. Each constructor 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.).

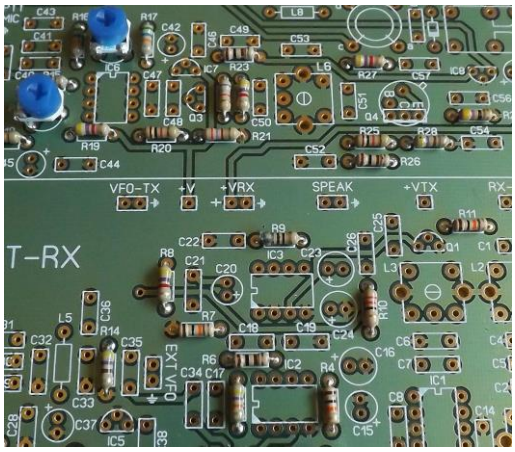
RECOMMENDED ASSEMBLY SEQUENCE

❒ **Resistors.**

The resistors are installed first. Mount all the resistors R1 to R35 and trimmers P3 – P4.
P1 is the Rx gain potentiometer and P2 is the TUNE potentiometer, which will 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, 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 of the ends. 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 hold 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 them, cut the excess length off the component leads 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 resistor value.



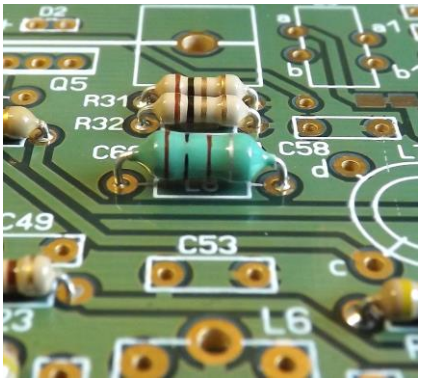


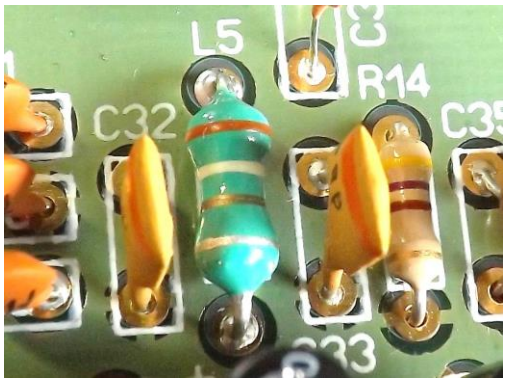


❒ Axial Inductors

L5 and L8

These components look like thick-bodied resistors and the body is colored blue or green. In its 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, but leave a separation of 1-1.5mm from the board.





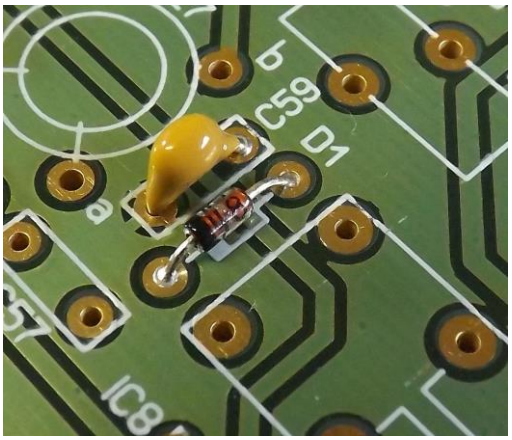
❒ Diodes

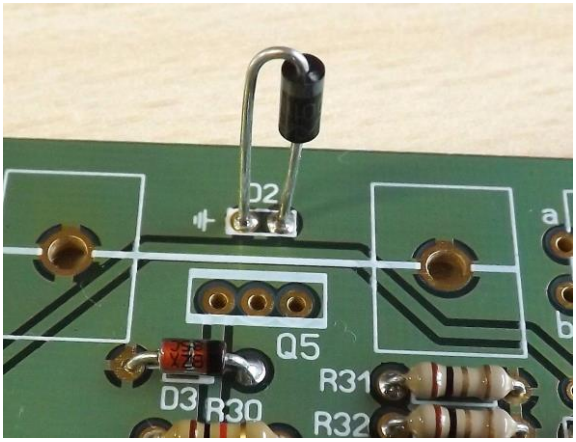
Next mount the diodes, being careful to place them with the correct orientation. There is a band on one end of each diode that corresponds to the component outline on the circuit board.

D1 is 1N4148; it is normally orange in color with a black band and has the type “4148” printed on the body.

D3 is a 47V zener diode. It is marked as BZX85C47 or Z47.

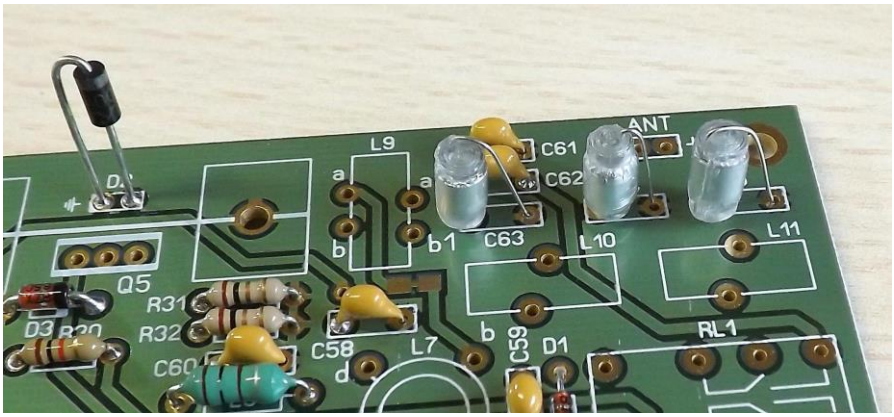
D4 is a zener diode marked as 9V1
D2 (bias limiter) 1N4007 or 1N4001 diode is black with a gray band. **This is placed vertically as shown in the picture** (about 10-12mm high). The end with the gray band goes to the hole marked GND





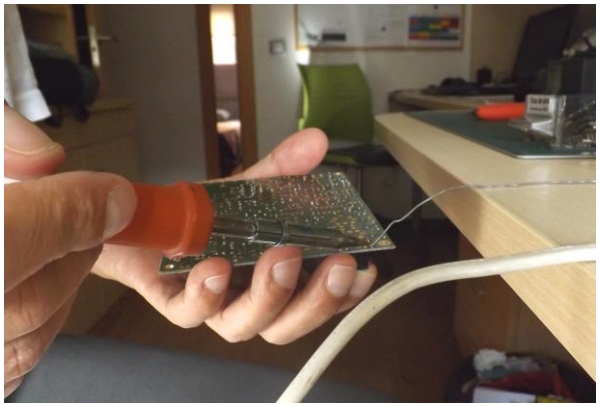
❒ Capacitors

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.
Install and solder all the capacitors C1 to C67 **(except C27 and C57 they are not used)**
When you mount them, make sure to leave the leads as short as possible.
C63, C64 and C65 are polystyrene capacitors; these are axial capacitors, but they must be placed in a vertical position.
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.



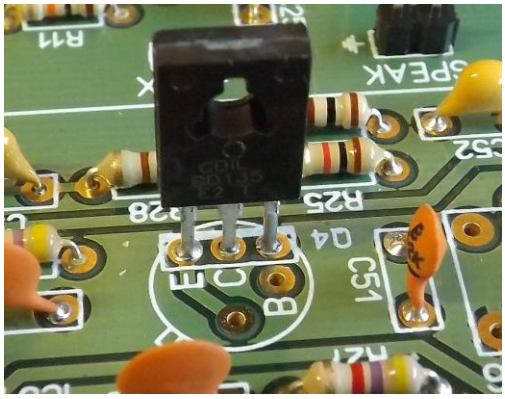
❒ Pin "headers"

To build the complete transceiver you must place pins in: MIC(3), 12-14V(2), ANT(2), SPEAK(2), EXT-VFO(2), J1(2)
Place “jumper” between pins “J1”.
Note: If you want to build only the RX section, then place these pins: +V(1), +VRX(2), SPEAK(2), and RX-ANT(2).
Turn the board over and 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!

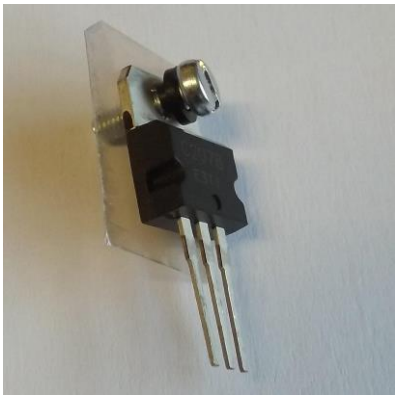


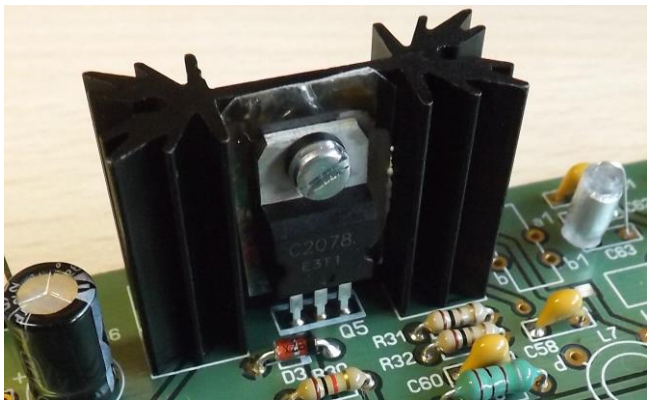
❒ Transistors

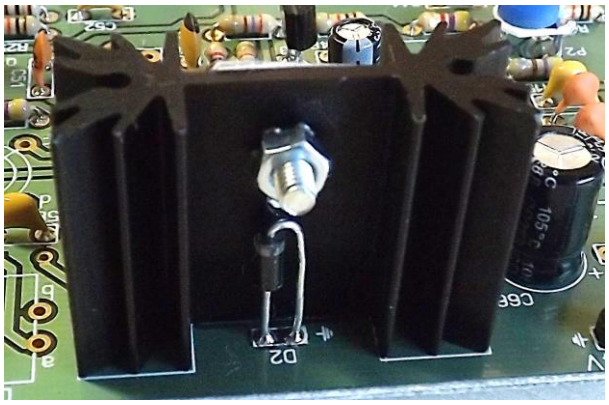
All of the transistors have their type printed on the component body. Place them according to the corresponding component outline printed on the circuit board.
Transistors Q1and Q2 of the type BC547.
Q3 is a PN2222
Q4 is a BD135; the face with printed letters should be facing the top of the PCB (L7, L9 etc.)



Q5 is the output TX transistor. See picture showing the position of Q5.
The case of Q5 should be electrically isolated from the heatsink. Use the plastic washer and the mica sheet provided with the transistor. Fasten it with the 10mm screw, nut and M3 washer. After mounting the transistor to the heatsink, verify with a multimeter that the transistor case does not make contact with the screw or with the heatsink. It is also recommended to apply a dab of thermal grease on both sides of the mica sheet. Note that the screw goes through the heatsink's upper hole.







❒ Integrated circuits

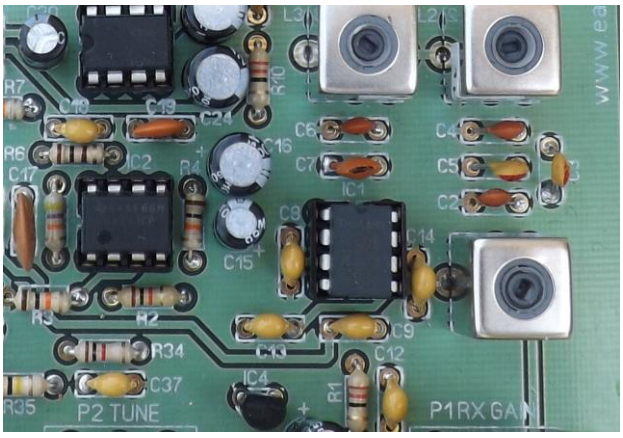
The component outline for the IC on the circuit board has a “U” shaped notch on one end, indicating the end at which pin 1 of the IC is located. There is a similar notch on one end of the sockets. This should be oriented over the "U" notch outline on the circuit board. Finally, pin 1 of the IC is marked 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 IC6 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 IC6 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.

Now, place and solder the voltage regulators IC4, IC7 (78L06) and IC8 (78L08) in their respective locations according to the markings of the component outline on the circuit board.



❒ Crystal X1, X2

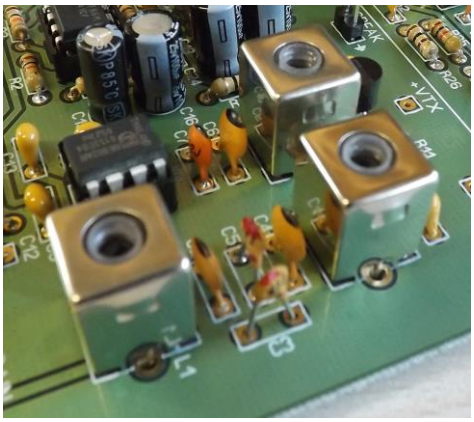
Install the pair of 14.270MHz crystals in X1 and X2 places.

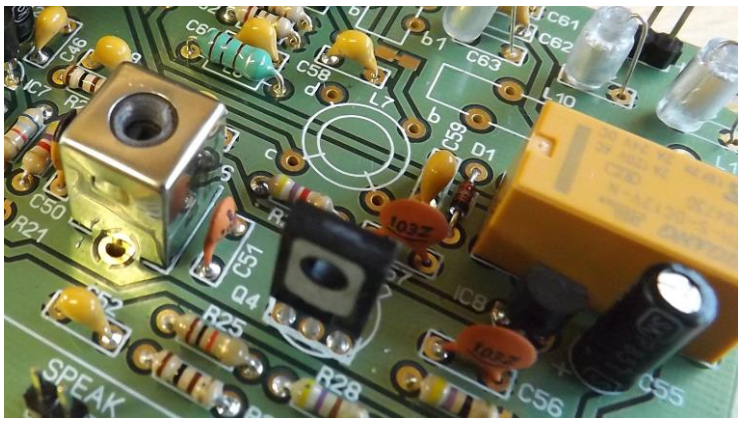
❒ Relay

Install relay RL1; it can only be mounted in one position.
Make sure that the body of the relay lies flat against the circuit board.

❒ Shielded coils (cans)

L1, L2, L3 and L6 are shielded coils equivalent to Toko KANK3335, marked as **1u2H**. They are RF transformers for the passband 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 or use a higher-wattage soldering iron.

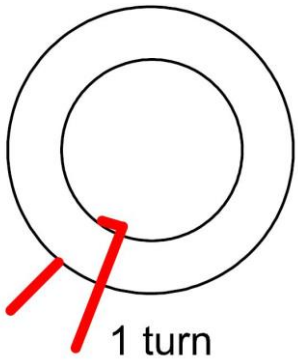


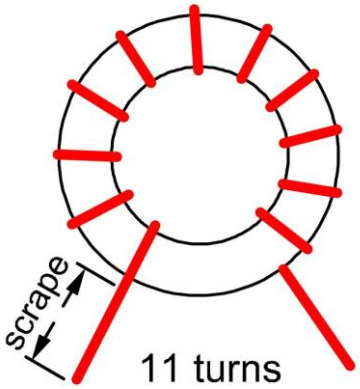


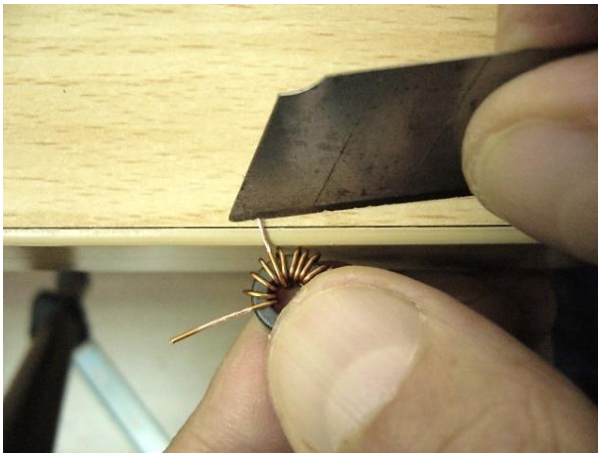
❒ LPF Toroids L10 and L11

L10 and L11 are identical. They use T37-2 cores (red toroid with 9.5mm/0.375in OD).
Cut 20cm (7,5”) of 0.5mm diameter enameled wire and wind eleven (11) turns on a red toroidal T37-2 core. 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 (0.4”). Scrape off the enamel with a cutter from the ends of the wire, in order to solder the toroid onto the board.
Counting the turns: Count one turn for every time the wire passes through the center of the toroid.
Important: wind the toroid exactly as shown in the pictures.

One turn more or less will affect the operation and the power output.





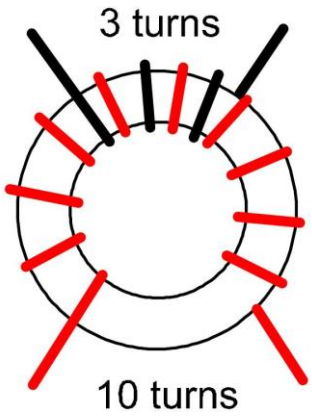


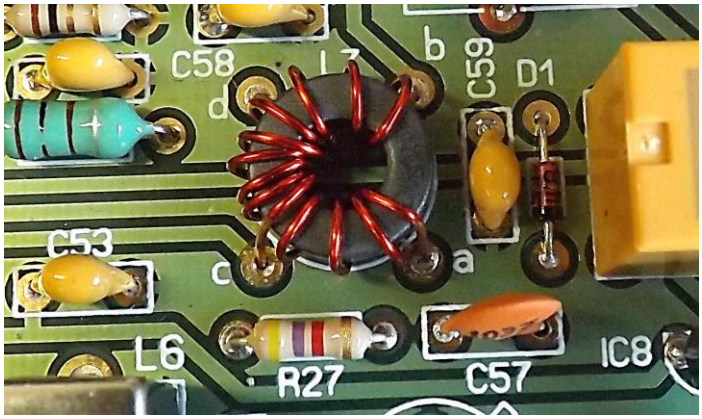
❒ Toroidal transformer L7

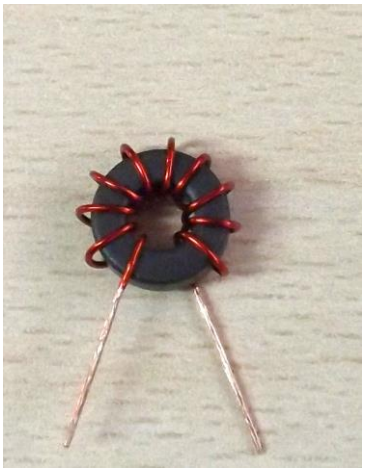
L7 is an impedance matching transformer. An FT37-43 is used (black toroid with 9.5mm/0.375in OD). It has a 10-turn primary and a 3-turn secondary.

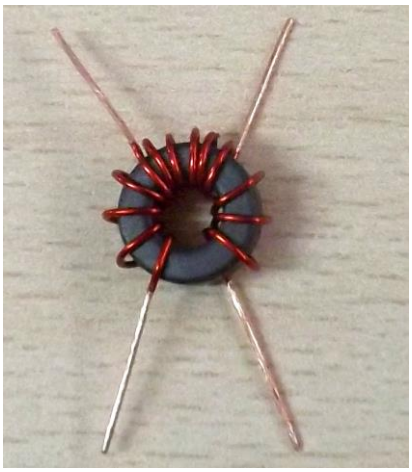
- Take 17cm (7.5”) of 0.5mm diameter enameled wire and wind ten (10) turns on a black FT37-43 toroidal core. Spread the turns evenly around the toroid and wind them tightly so that so that they follow the contour of the toroid and are as tight against the toroid as possible. The turns should be evenly distributed around the circumference of the toroid. Leave pigtails of 10-20mm (0.70”).
- Now take about 8cm (3.5”) of 0.5mm diameter enameled wire and wind three (3) turns on the other side of the toroid, spacing the turns within the space between the turns of the previous winding. Leave pigtails of 10-20mm (0.70”).
- Before inserting them on the circuit board, use a cutter or sandpaper to scrape off the enamel from the pigtails of the windings. Solder them in place. Mount the toroid with approximately 0.5 - 1mm distance from the board.
- The ends of 10-turn winding to into holes “a” and “b” facing towards relay RL1. The ends of 3-turn winding go to “c” and “d” facing towards L8 and C53 (place exactly as shown in the pictures).

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









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

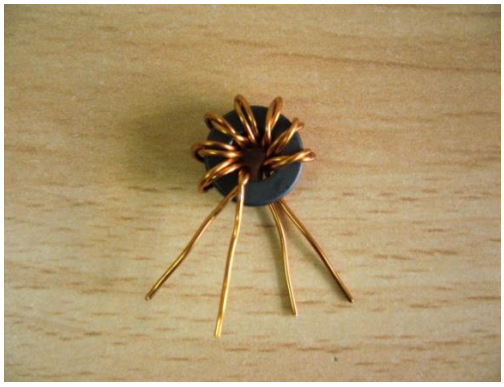
❒ Toroidal transformer L9

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

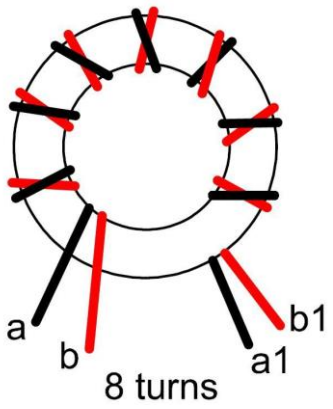
- Cut a 31-32cm (12in) long piece of 0.5mm diameter enameled wire.
- Bend the wire in half.
- Twist it so that there are about two twists per cm.

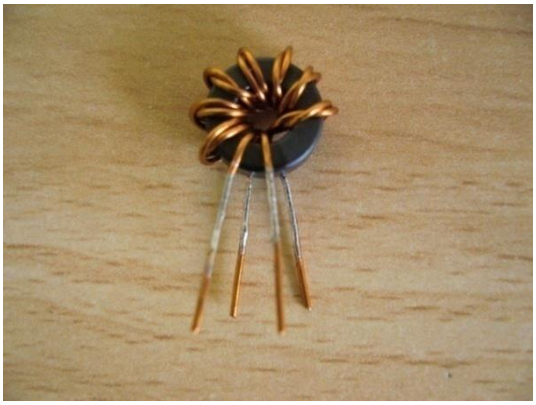
16cm (32 cm bent in half)

- 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 every time the wire passes through the center of the toroid.

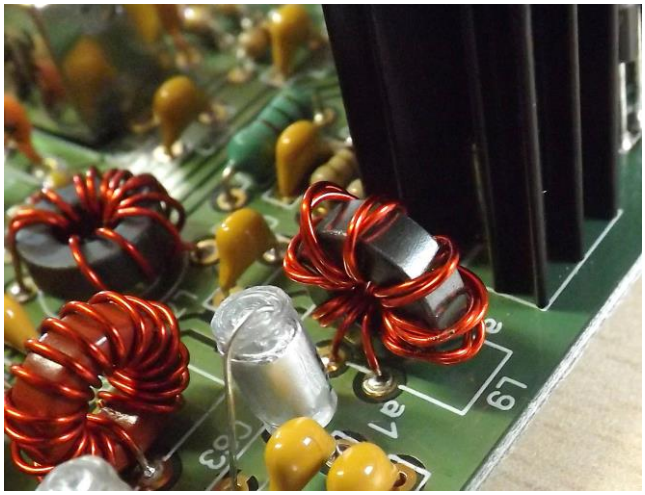


- Spread the turns evenly around the toroid.
- Cut the ends and separate the two windings.
- Use a sharp X-Acto knife to scrape the enamel off the ends that will be soldered. The ends of the coils that we have made need to be prepared in this manner before soldering them into the board.
- Using a multimeter 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.



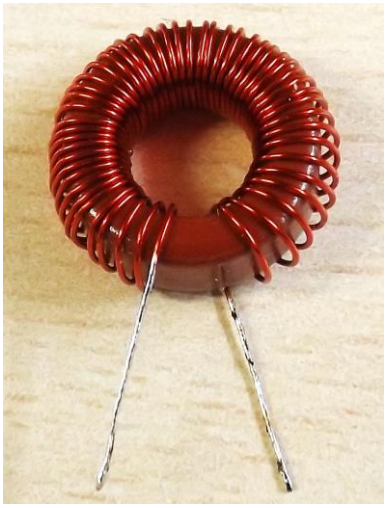


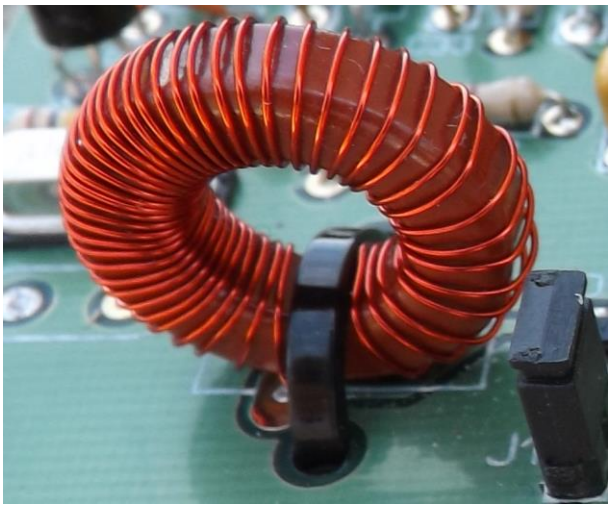
Note: For greater clarity, the drawing shows one black wire and one red wire. In reality, both wires are of the same color.



❒ L4 VXO Tuning Inductor

A T68-2 is used (red toroid with 12.mm/0.5in OD).
Cut about 90cm (36in) of **0.3mm enameled wire** (the thinnest), then forty three (40) turns.
Leave an extra 1.5-2cm pigtail of wire on each end.





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.

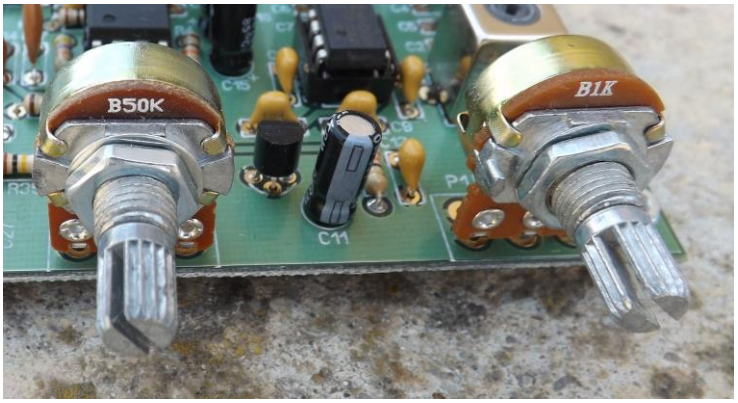
IMPORTANT: DO NOT MOUNT toroid L4 yet. It will be installed later, in the last section for adjustment and testing.

❒ RX Gain Potentiometer P1 (Volume)

Install the RX Gain potentiometer P1 as shown in the picture.
You may prefer to mount this component on the front panel, off the circuit board. There is no problem in doing this if the wires are short.
Bend and break the small tab protruding and will not bother when you screw on the front.

❒ TUNE Potentiometer P2 (Tuning)

Install the Tune potentiometer P2 as shown in the picture.
This is the tuning knob which it will cover about 50-60KHz of the band. To tune in with certain comfort we recommend using a control button at least 20-30mm diameter.



ADJUSTMENTS AND TESTS

❒ Preliminary adjustment

- Adjust P3 (mic gain), P4 (carrier suppression) and P1 (RF gain/volume potentiometer) to mid-position.
- Connect a speaker or headphones to the “SPEAK” pins on the circuit board.

IMPORTANT: Use a high-quality speaker box. A bad speaker will make ineffective the operation of the transceiver.

- DO NOT yet connect a microphone.
- Apply power supply voltage (12-14V) to the “12V” header pins on the circuit board.
- Turn the volume to maximum; you should hear a hissing noise in the headphones or speaker.

Note: For the VFO to reach its maximum stability it is recommended to wait about 5 minutes.

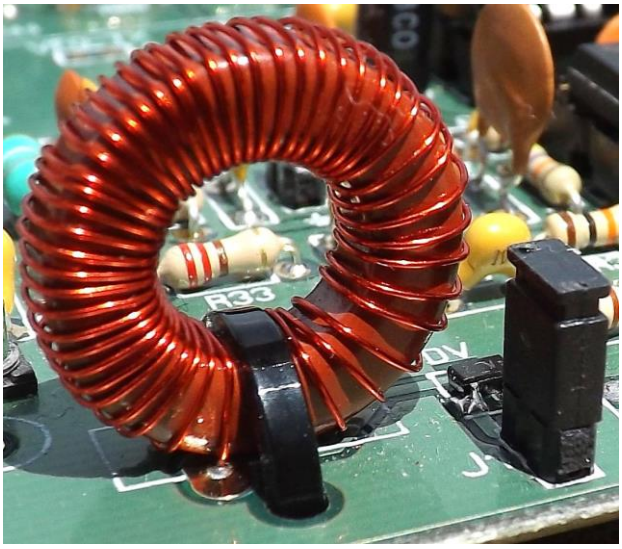
❒ L4 and VXO frequency coverage

Solder the pigtails of L4 in place on the circuit board.
Connect a frequency counter to the “VXO” header. If the input of the frequency counter is low impedance, insert a 470 ohm (or greater) or a small value capacitor (try with 22pF or less) between the frequency counter and the header to reduce the interaction with the VXO.

If you don't have access to a frequency counter, you may use a high-quality SSB or CW receiver that covers the VXO frequency (20m band) and that has digital frequency readout. Connect to the receiver antenna input a piece of wire with a small loop and place it close to the MFT-20.
Spreading or compressing the turns of L4 changes slightly the range of coverage. Compressing the turns increases the inductance, thus increasing the frequency range. If the turns are spread, the inductance and thus the frequency coverage decreases. The final adjustment should do so after holding the L4 definitively.
Frequency coverage with 14.270MHz X1 and X2 quartz crystals, L4 T68-2 toroid with 43 turns and jumper J1 placed is approximately 14.175 to 14.250MHz.

Once you are sure that the VXO range will suit your needs, you will need to secure L4 in position on the board. ***The most effective and cleanest option*** is to use a small plastic tie-wrap, passing it through the holes in the circuit board as showing in the picture.
Once the tie-wrap is fully tightened, you will still be able to move the turns slightly and make slight adjustments before securing them with a little bit of nail polish.
Another way to hold L4 may be using a little bit of hot melt adhesive or similar.

L4 should be well secured; this is *very important, since vibrations may change the VXO frequency, causing frequency "flutter" in the received and transmitted signals.*
IMPORTANT: Prior to permanently securing L4, make all of the transceiver adjustments and checks and confirm that the frequency coverage suits your needs.



I recommend this number of turns and type of toroid for L4. It works well! However, you can modify and experiment with the inductance to try a different coverage. With just one more turn will increase inductance and the coverage, but if you add more turns reduce the stability and the VXO may even stop oscillating, and vice versa.
In order to obtain good stability, a maximum coverage of 50-60 KHz is recommended.
In addition, a wide coverage will make tuning difficult, and it will be necessary to add a fine tuning control by using gear reduction on the P2 potentiometer or a fine tuning circuit.
If you have graphical ability, you can draw a dial on the front panel with a frequency scale to serve as a guide.
In order to put us in other segment of the band different from the specified here, you will need to use VXO crystal with different frequency. Some factories accept orders non-standard frequencies but the costs for a single crystal are very expensive.

❒ Adjustment of the RX pass band, L1, L2 and L3

For this adjustment you will need an “alignment” tool suitable for this type of coils; if you use a screwdriver, you risk of breaking the core of the coil.
With an 14MHz band antenna connected to the transceiver, sequentially adjust L1, L2 and L3 until obtaining the maximum level of noise in the speaker. Now, try to tune in a stable signal within the band and readjust L1, L2 y L3 until you hear it at the highest possible level.
If you have access to an RF generator, begin injecting a signal of about 5uV within the frequency coverage of receiver and tune it in. Reduce the level of the RF generator to the minimum that is still audible with a loudspeaker or headphones, and sequentially adjust L1, L2 and L3 until obtaining the maximum reception level.

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

❒ Adjustment of the TX transformer L6

Connect a power meter with a 50 ohm load to the antenna jack.
Adjust the mic gain P3 to maximum. Push to talk, (put the transceiver in transmit mode, PTT to “GND”). Speak loudly or whistle in front of the microphone and adjust L6 to achieve maximum output power.

❒ Adjustment of DSB carrier suppression P4

Connect a power meter with a 50 ohm load to the antenna jack.
Adjust the mic gain to minimum (completely clockwise). Adjust P4 (carrier suppression) to mid-position.
If you have access to an oscilloscope you can monitor the power output to make this adjustment.
If you do not have access to instrumentation, you can tune an amateur radio receiver to the frequency of the MFT transceiver.
Push to talk, (put the transceiver in transmit mode, PTT to “GND”) and adjust P4 until the minimum residual carrier at the transmitter output is obtained. (or minimum signal is heard in the receiver).

If you do not have oscilloscope or receiver, then set P4 to mid-position.

❒ Adjustment of mic gain P3

This adjustment will be a little ambiguous, since it depends a lot on the operator's type of voice and way of speaking. Use the “cut and try” method. To get the maximum power you can set P3 almost to the maximum. If you want to work with very low power (QRPp) you can set P3 to a low level.
It is recommended that you request a fellow operator to critique your modulation.

Normally the position in 75% of the route is correct

USEFUL NOTES

❒ Using a mechanical reduction dial or a 10-turn potentiometer

Although 50-60KHz can be tuned perfectly with a one-turn potentiometer and a large diameter control knob. You have the possibility to replace the potentiometer by a 10-turn or add a mechanical reducer dial (see components at www.ea3gcy.com)

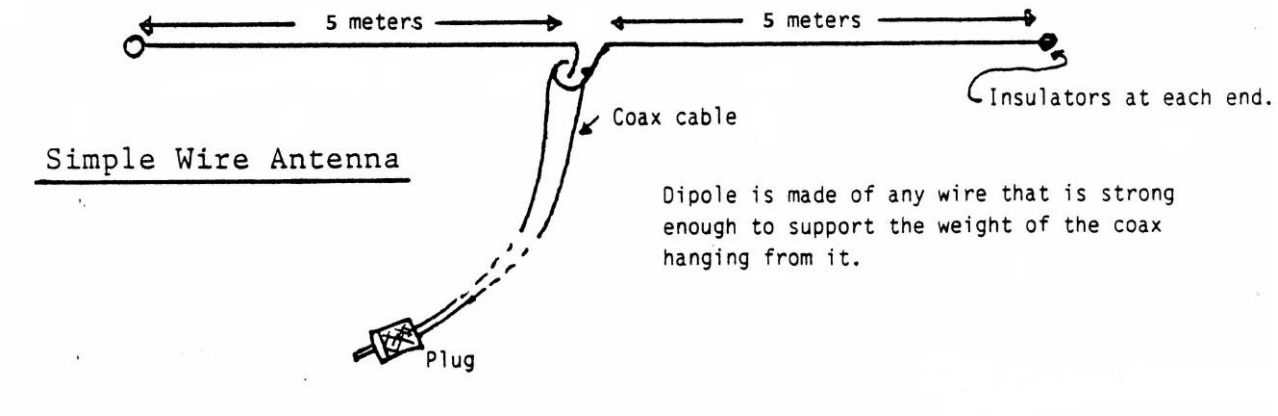
❒ Changing Frequency Coverage Range

- Adding one or two turns to the toroid L4 can easily achieve a range of 70-80Khz or more, but keep in mind that: **the greater the coverage, less stability**.
- Placing a capacitor in C27 will add to the capacity of the DV varicap diode and the frequency will decrease, but the coverage will be smaller. Try small values such as 10p, 22p etc.

EA3GCY Kits does not respond to possible malfunctions by experimenting and making modifications.

❒ 20 meters band Antenna

To obtain a good performance of the MFT-20, it is essential to use a specific antenna for the 14MHz band. You can use a special factory ham radio antenna. Or you can build your own dipole antenna for very little money and that will give you very good results.



For the antenna "arms" you can use any cable strong enough to hold the weight of the coaxial cable hanging. Install the antenna in the highest and clearest position possible.

❒ "Broadcasting" Interference

An inherent problem in direct-conversion (DC) receivers is the broadcasting interference. This occurs at certain times of the day with different magnitudes depending on the area of the world where it lives and the propagation.

You will be able to hear some background broadcasting station throughout the coverage of the receiver, without the tuning control having any effect.

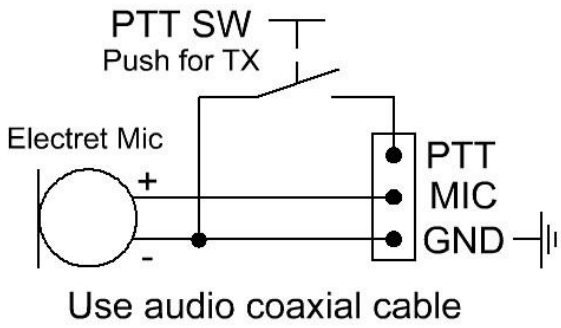
In a very simple way we can explain that the IC of the receiver input is "modulated" by the strong interfering signal and AM detection is produced and boosted directly by the audio amplifiers.

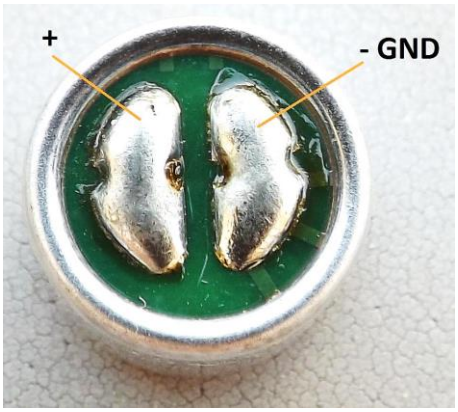
To minimize or eliminate these interference, try the following:

- Use a single-band antenna instead of multi-band or broadband antennas.
- Keep the RX-GAIN knob to minimum, use headphones or an external amplified loudspeaker.
- If you have a tuner or antenna coupler use it even if the antenna is set correctly.
- Normally the interference will appear at the same time of day; Avoid working with the receiver during those hours.

❒ Electret Microphone Capsule

You can use a micro electret for amateur radio and adapt the connections to the MFT or build your own micro. The connection scheme is very simple:





Or you can build your own handheld microphone with the micro electret capsule included in the kit and a pushbutton for PTT (not included):

Mic “home made”

Handheld mic optional (ea3gcy.com)

IF YOUR KIT DOES NOT WORK AFTER 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 of faults are due to poorly soldered connections or misplaced components; it is very rare to find a faulty component. 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.

To help troubleshoot your transceiver, the following voltage table may be useful. The IC and transistor voltages were measured in receive **(without volume)** and transmit **(without modulation)**. If there is a fault, it is quite likely that one or more of the readings will be very different.

IC Ref.	Type	Pin1 RX	Pin1 TX	Pin2 RX	Pin2 TX	Pin3 RX	Pin3 TX	Pin4 RX	Pin4 TX
IC1	NE603	1.38	0	1.30	0	0	0	4.75	0
IC2	UA741	0	0	6.75	0	6.75	0	0	0
IC3	LM386	1.38	1.38	0	0	0	0	0	0
IC4	78L06	6V out	0V out						
IC6	NE602	1.05	1.05	1.05	1.05	0	0	4.99	4.99
IC7	78L06	6V out	6V out						
IC8	78L08	0V out	8V out						

IC Ref.	Type	Pin5 RX	Pin5 TX	Pin6 RX	Pin6 TX	Pin7 RX	Pin7 TX	Pin8 RX	Pin8 TX
IC1	NE602	4.77	0	5.87	0	5.12	0	5.92	0
IC2	UA741	0	0	6.73	0	13.37	0	0	0
IC3	LM386	6.63	6.63	13.40	13.25	6.69	6.61	1.39	1.39
IC6	NE602	4.99	4.99	5.83	5.83	5.13	5.13	5.91	5.91

Q Ref.	Type	B Rx	B Tx	E Rx	E Tx	C Rx	C Tx
Q1	BC547	0	0.70	0	0	0	0
Q2	BC547	3.74	3.90	4.89	4.80	7.90	7.90
Q3	PN2222	0	1.53	0	092	0	12.36
Q4	BD135	0	2.30	0	1.70	13.42	13.48
Q6	2SC2078	0	0.65	0	0	13.42	13.48

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.

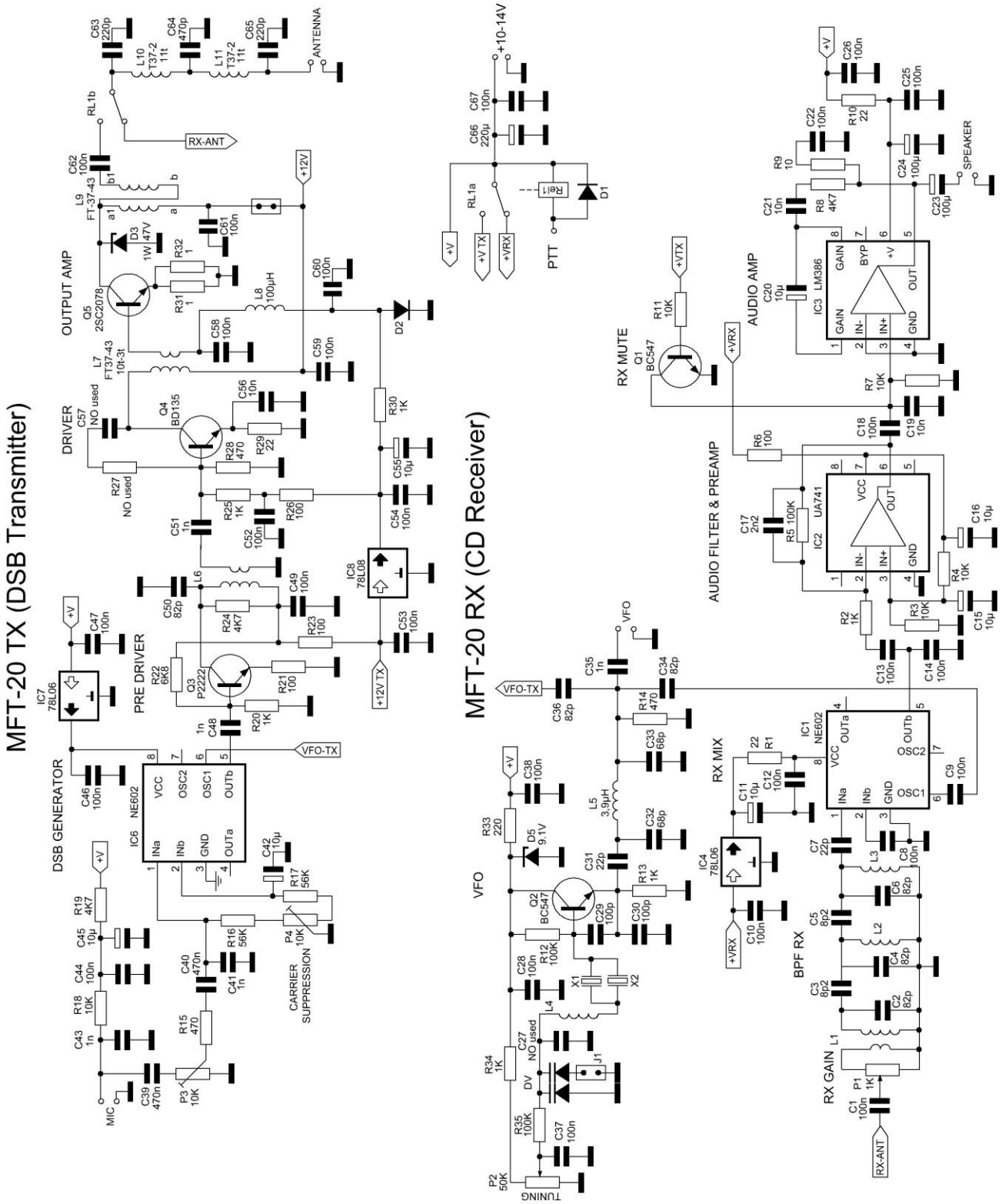
The original purchaser has the option of examining the kit and manual for 10 days. If, within this period, the buyer decides not to build the kit, he/she may return the entire unassembled kit at their own expense for the shipping expenses. The shipping expenses and sales commissions (i.e. bank, Ebay, 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, if 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 component for the kit, 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 MFT-20 DSB Transceiver kit.
Enjoy QRP!
73 Javier Solans, EA3GCY

SCHEMATIC

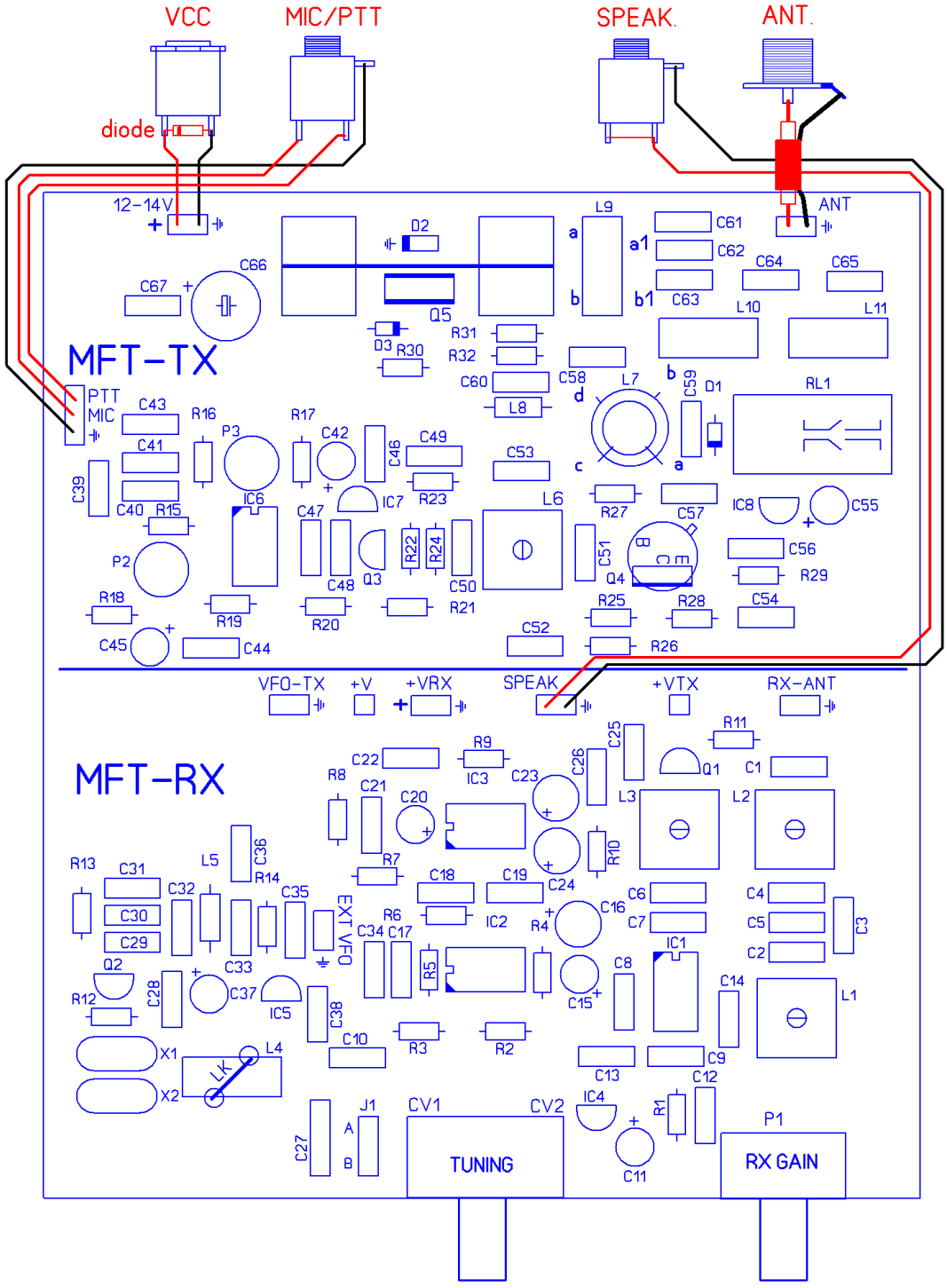

MFT-20 TX (DSB Transmitter)
MFT-20 RX (CD Receiver)
DSB GENERATOR
PRE DRIVER
DRIVER
OUTPUT AMP
CARRIER SUPPRESSION
VFO
RX MIX
BPF RX
RX GAIN
AUDIO FILTER & PREAMP
AUDIO AMP
RX MUTE
PTT
ANTENNA
SPEAKER
TUNING
RX-ANT
MIC
+10-14V
+12V
+12V TX
VFO-TX
+VTX
+VRX
+V TX
+V

WIRING for TX + RX full use

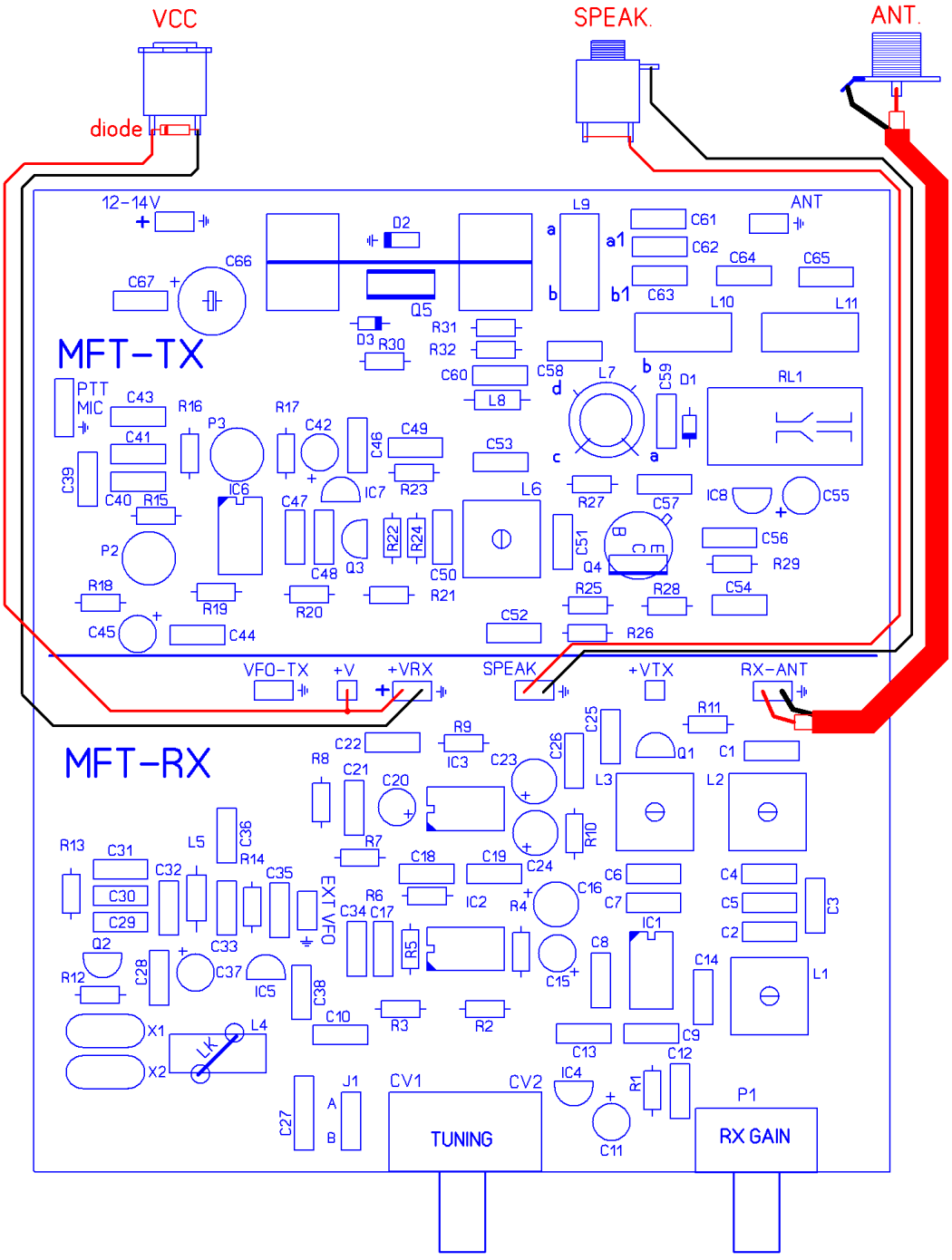
RX+TX Transceiver use (normal use)

Note that if you use the RX along with the TX, you do not have to connect anything in “VFO-TX”, “+V”, “+VRX”, “+VTX” and “RX-ANT” terminals.

The "VFO-TX" and "VTX" terminals are arranged to use a different transmitter.



WIRING (To use RX only)



The MFT-20 transceiver wiring is very simple, as long as you remember that:
- For the antenna connection use a thin, RF-rated coaxial cable such as RG-174 or similar.
- If you install the tuning polyvaricon off the circuit board, you should use short and stiff wires, as the mechanical stability is very important.
-A metal box is highly recommended.

If you use a plastic box, then it is highly recommended screen the inside with aluminum foil or shielding screen tape.

The MFT-20 is not protected against reverse polarity!

It is a good idea is to place a diode (i.e. BY255 or larger) in parallel with the power supply input. The cathode (the end of the diode with the printed band) goes to the positive wire. If your power supply has short-circuit protection or has a fuse on its output, fine; otherwise, you will need to build or buy a cable with an in-line fuse in series.

SPEAK[ER]

If you use headphones, you must join the two terminals of the connector so that you can hear the sound through the two channels.

RX only

+VRX +V terminals

Note that to use the receiver section alone, you must attach the + VRX terminal to the + V.