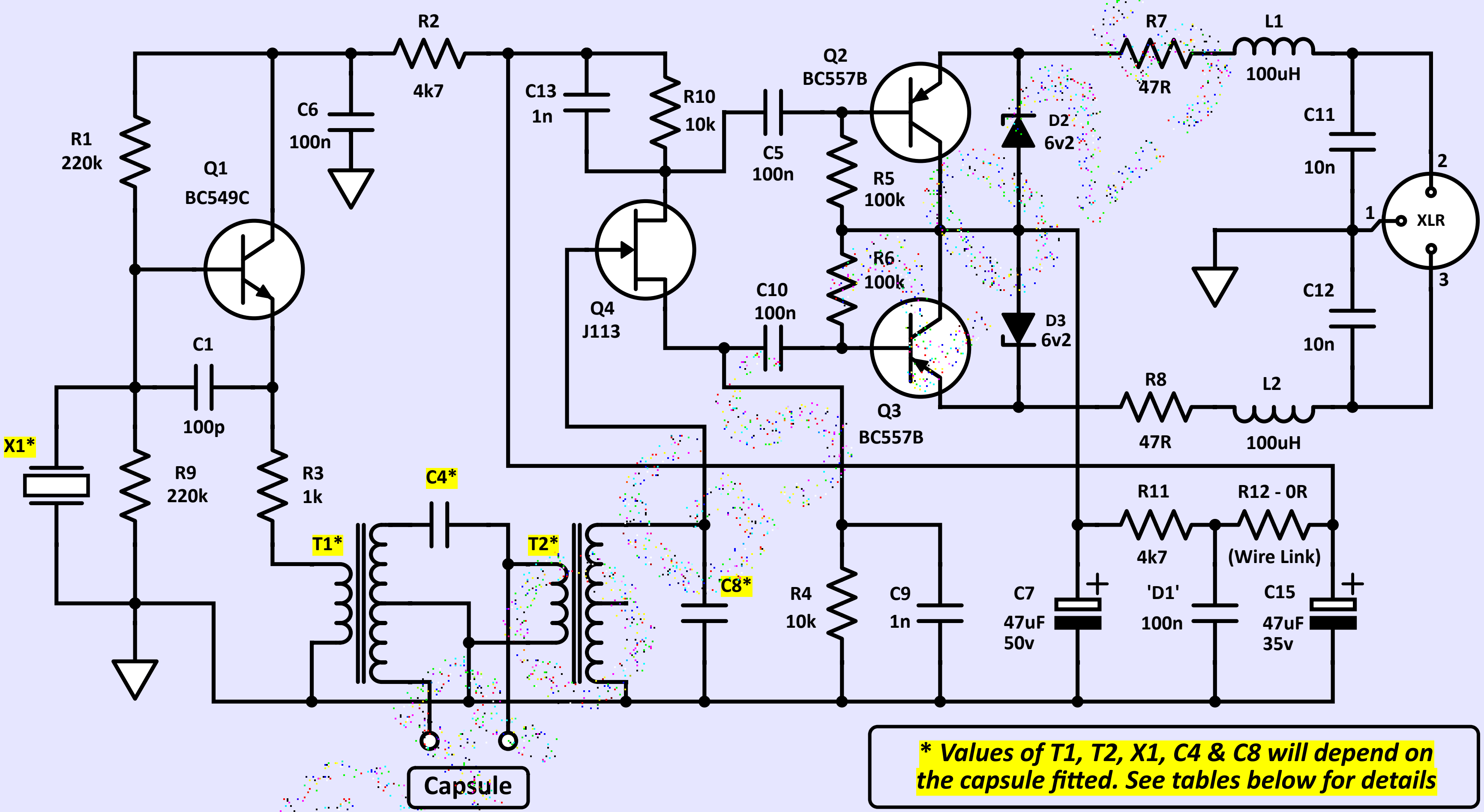
RF.AMX10 v.6

DIY RF Condenser Microphone – Schematic

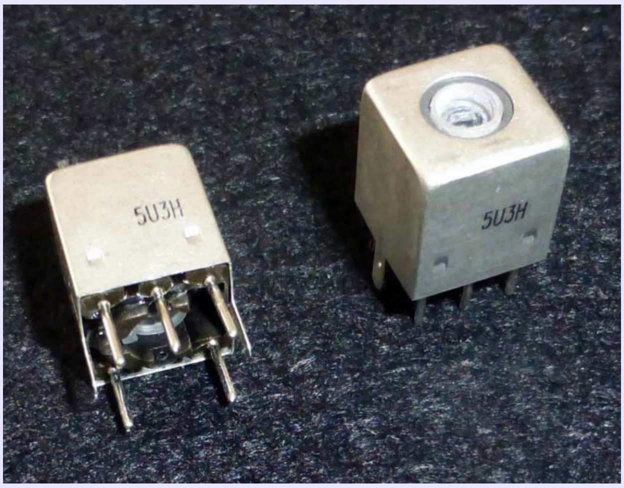


*** Values of T1, T2, X1, C4 & C8 will depend on the capsule fitted. See tables below for details**

Capsule	T1 (uH)	T2 (uH)	X1 (MHz)	C4 (pF)	C8(pF)
40pF	22	6	8	33	68
45pF	22	6	7.37	39	68+22
50pF	16	6	8	33+10	68
55pF	16	6	8	47	68
60pF	16	6	7.37	56	68+22
65pF	16	6	7.37	47+10	68+22
70pF	12	6	8	33+33	68

Capsule	T1 (uH)	T2 (uH)	X1 (MHz)	C4 (pF)	C8(pF)
75pF	12	6	8	68	68
80pF	12	6	7.37	39+33	68+22
85pF	12	6	8	56+15	68
90pF	8	6	8	47+39	68
95pF	8	6	8	56+33	68
100pF	8	6	8	47+47	68
105pF	8	6	8	100	68

AMX10.v6 RF Condenser Microphone Project
• INDUCTORS •



The Spectrum type 5u3HH coils, which were originally specified as the nearest 'off the shelf' inductors for this project are only really effective within a fairly limited range of capsule capacitive values.

If the capsule values are smaller than 65pF – or greater that 80pF - these inductors tend to perform less well, although useful results can still be obtained.

To combat these problems, it is possible to construct your own inductors using an almost identical coil former which is available cheaply from Aliexpress. See here:

https://www.aliexpress.com/item/1005003604363316.html

These can be used in conjunction with 0.1mm enamelled copper wire (magnet wire) which is widely available from a number of sources…. Like here for example:

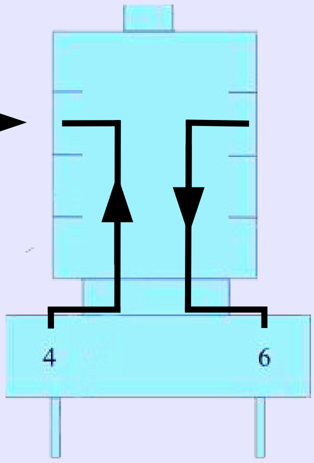
https://www.aliexpress.com/item/1005002084489140.html

The notes below show how a range of inductors can be constructed, to enable a better 'match' for a wider range of capsule capacitive values.

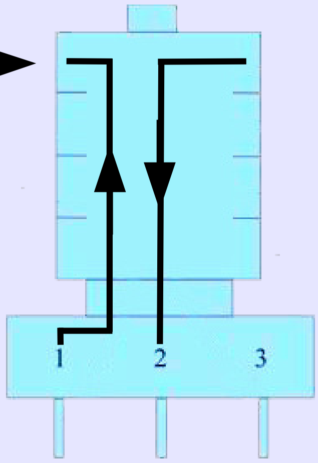
The tables attached to the RF.AMX.v6 schematic show the appropriate component values best suited to match specific capsule capacitances.

AMX10 COIL WINDING DETAILS

Primary winding
(FIT FIRST)
(2nd *tier of bobbin*)
* x turns clockwise



Secondary winding
(1st half)
*x turns clockwise
(*top tier of bobbin*)



** Number of turns for each winding for different value inductors (turns ratio c.1:5)*

6uH -
Primary: 4
Secondary: 10+10

8uH
Primary: 5
Secondary: 12+12

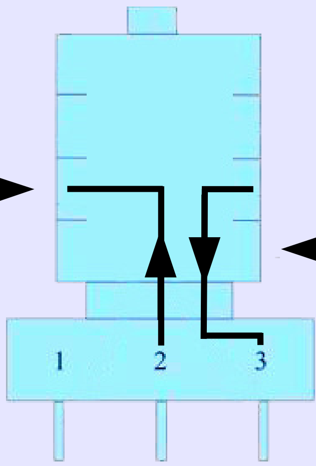
12uH
Primary: 6
Secondary: 15+15

16uH -
Primary: 7
Secondary: 17+17

21uH -
Primary: 8
Secondary: 20+20

Solder start of this second winding to pin 1
- wind *x turns clockwise -
Solder exit of winding to pin 2, and continue
that winding to second half shown below

Secondary winding
(2nd half)
*x turns clockwise
(3rd tier of bobbin)



(4th (lowest) tier of bobbin is not used)

Continue winding from pin 2, and terminate
final exit of secondary winding to pin 3

RF.AMX10 v.6.0: Circuit Description

This circuit is designed to be connected to a low impedance, balanced XLR microphone pre-amplifier, which must have the option of providing 48V phantom power.

It consists of four functional sections:

• RF Oscillator • Modulator/ Detector • DC Power • Audio Output

• RF (Radio Frequency) Oscillator:

The circuit components connected to Q1 form a crystal controlled Colpitts type oscillator. Around 30% of the c.6V (p-p) sine wave present at Q1 emitter, is connected to the primary winding of T1 via R3. With the values shown, the oscillator draws around 2.5mA from the 48V phantom power supplying the circuitry.

• Modulator/Detector:

TI and T2 are constructed from standard IF transformer blanks, with the turns ratio determined by the capsule capacitance (See the AMX10.v.6 schematic for details)
One end of the centre tapped secondary winding of T1 is connected to one terminal of C4, a capacitor selected to have a value slightly lower than the measured capacitance of the capsule (see schematic for more details). The other C4 terminal is connected to one termination of the microphone capsule. The second termination of the capsule is connected to the remaining end of T1 secondary.
This arrangement provides a slightly unbalanced tuned 'bridge' circuit, where the 'balance' is further modified by the changing capacitive value of the capsule, as it responds to audio stimulation.

This change of the bridge balance state will enable amplitude modulation of the RF oscillator, in proportion to the applied audio stimulus.
These changes in capacitive value tend to be extremely small - in the order of 0.001pF for an alternating pressure of around 1 dyne/cm² (i.e. normal speech level signals at around 30cm.)

T2 is also a tunable IF can mounted transformer, and one end of the primary winding is connected to the centre of the capacitor 'bridge' across T1 secondary. The other end is connected to the centre tap of T1 secondary (which is also referenced to ground).
T2 secondary winding is loaded with C8, which allows the inductor core to be adjusted to resonate at the crystal frequency. The high 'Q' of T2 when tuned will allow the tiny changing bridge imbalance signal to be 'stepped up' by T2 to a higher AC voltage on its secondary winding, without introducing any further noise. This voltage is presented to the gate of the J113 FET Q4.

Note that the very high impedance of the JFET gate essentially presents no additional load to T2.

Q4 acts as both an infinite impedance detector and an audio phase splitter. The JFET is self biased, so that it is biased around Vp, the JFET 'pinch off' point, with the grounded gate effectively negative to the voltage on the source.

The infinite impedance detector function of the JFET takes the RF carrier present on the gate - which is amplitude modulated by the varying capsule capacitance - and uses it to charge both C9 and C13 on every positive going half cycle of the carrier. These two capacitors are then partially discharged - through R10 and R4 respectively - during the negative half cycle of each carrier wave, where the JFET is turned off. The capacitors are then recharged on the next positive half cycle, to a level set by any change in RF carrier level (amplitude modulation) caused by any new variation in the capsule capacitance.
The end result of this process is a demodulation of the RF waveform, so that only the audio portion is retained. The values of R4/C9 and R10/C13 are selected to allow an appropriate maximum high frequency audio limit to be applied to the signal.
Because the inherent self bias of the JFET ensures that Q4 is always biased around cut-off, the rectification of the signal does not require the bias of a conventional rectifier diode.

In addition to the infinite impedance detector function, Q4 also serves as an audio ‘phase splitter’, presenting opposite phase audio signals at the source and drain terminals.

• DC Power:
Power for the unit is derived from the 48V phantom power presented to the circuit via the 3 pin XLR male connector XLR1. Q2 and Q3 are configured as emitter followers, with common collectors connected to the positive terminal of C7. This arrangement is generally known as a 'Schoeps' style output circuit, and is widely used for this type of device.
R11 and C15 - together with the 100nF capacitor now fitted into the 'D1' location - form additional low pass filtering which will help to decouple and remove any noise that may still be present from less than perfect 48V phantom power supplies.
This smoothed DC voltage of around 20V is connected to the junction of R2 and R10, to provide DC power to both the RF oscillator based around Q1, and the infinite impedance detector/ phase splitter based around Q4. The oscillator circuitry is further decoupled by R2/ C6.

• Audio Output:
The audio outputs present at the drain and source of Q4 are connected - via C5 and C10 - to the bases of Q2 and Q3. These are configured as emitter followers, and present a low impedance audio path via R7 and R8 to pins 3 and 2 of XLR1 respectively.

The polarity of the audio signals will depend on whether the vlaue of C4 is larger or smaller than the capacitive value of the capsule. A smaller value is the preferred option for maximum sensitivity.

L1 and L2, C11 and C12 are included as low-pass filters to remove any residual RF from the audio output.

RF.AMX10 v.6.0

PCB Parts List (3.25)

Resistors -

R1 - 220k	R7 - 47R
R2 - 4k7	R8 - 47R
R3 - 1k	R9 - 220k
R4 - 10k	R10 - 10k
R5 - 100k	R11 - 4k7
R6 - 100k	R12 – 0R (wire link)

- All 1% 1/8w metal film - MF12 series
- 47R x 2, 1k x 1, 4k7 x 2, 10k x 2, 100k x 2, 220k x 2

Capacitors -

C1 - 100pF	C8 - * see schematic
C2 - not fitted	C9 - 1nF
C3 - not fitted	C10 - 100nF
C4 - * see schematic	C11 - 10nF
C5 - 100nF	C12 - 10nF
C6 - 100nF	C13 - 1nF
C7 - 47uF 50V	C15 - 47uF 35V

- C1, C4, C8. C11, C12 and 'D1' are Vishay K series - class 1 C0G 50V MLCC
- C5, C6, C9, C10 and C13 are Multicomp MCPBSFC series - 63V polyester
- C7 and C15 are Panasonic M series - 6.3mm diameter
- C2 and C3 are not fitted
- C14 is not present

Semiconductors -

Q1 - BC549C
Q2 - BC557B
Q3 - BC557B
Q4 - J113 JFET
'D1' - now fitted as 100nF COG MLCC
D2 and D3 - 6V2 500mW Zener diode - BZX79 series

Crystal -

- X1 (IQD) 8MHz: LF A140K or 10MHz: LF A143K (see schematic for frequency allocations)

Inductors -

- T1 & T2: https://www.aliexpress.com/item/1005003604363316.html or equivalent
  (see page above for construction details)

- L1 and L2 are 100uH RF chokes - Multicomp MCAL series: MCAL0410A1 - 101KU

(All components - (except T1 and T2) are available from CPC Electronics in the UK)