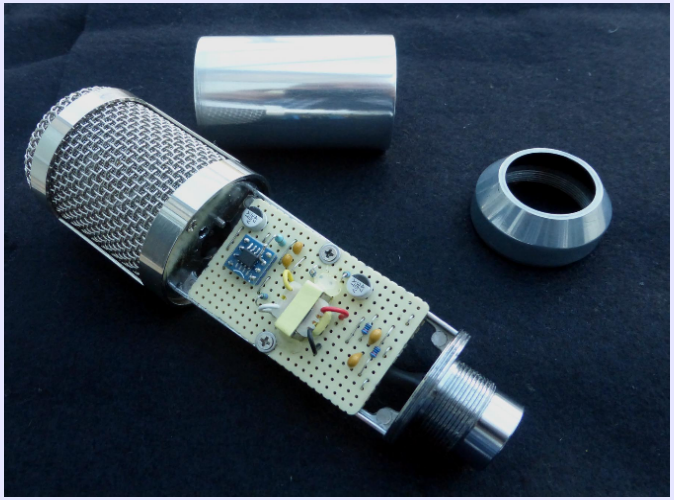
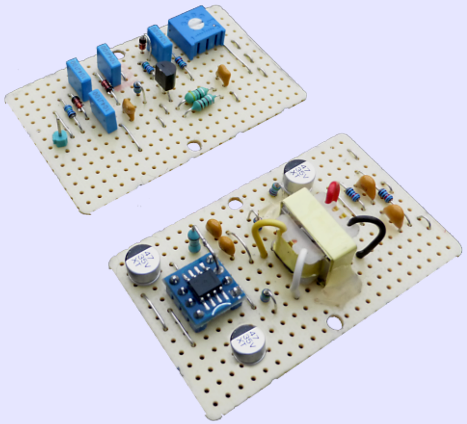
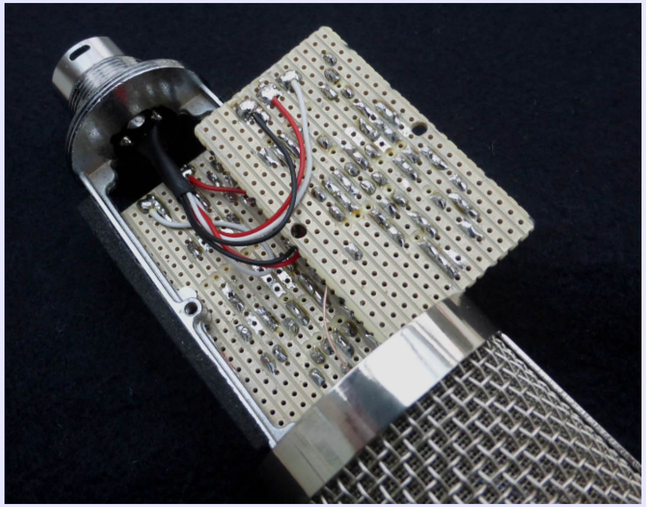
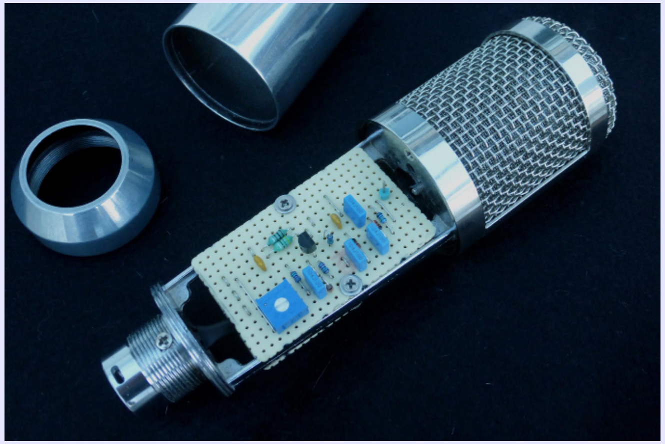
OPIC.TX3 (regulated)

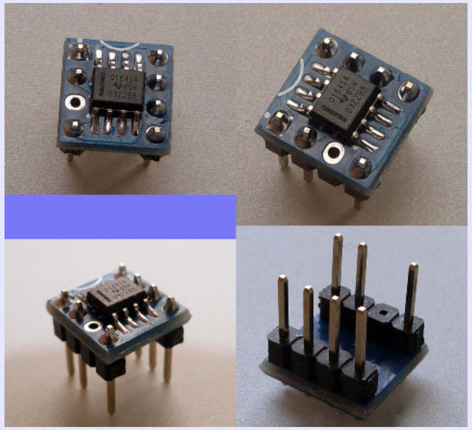
- **OPA1642 Impedance Converter with transformer coupled output**
- **Selectable High Pass Filter (2^{nd} order Chebyshev – Fc c.80Hz)**
- **Hartley oscillator based adjustable Voltage Multiplier**
- **Adjustable pad option**



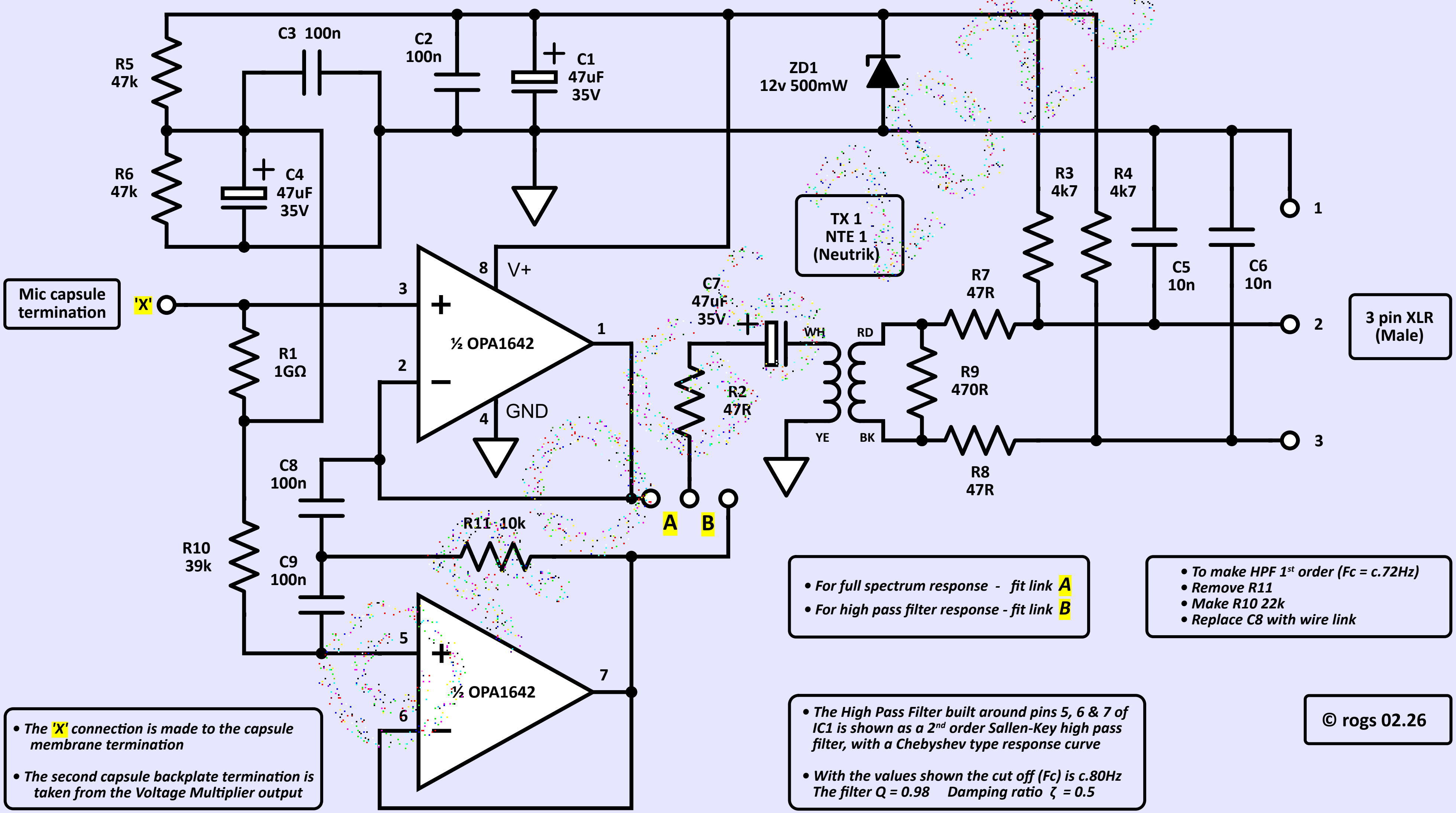








• Op Amp Impedance Converter with High Pass Filter OPIC.TX3 (regulated) Schematic •



- For full spectrum response - fit link **A**
- For high pass filter response - fit link **B**

- To make HPF 1st order (Fc = c.72Hz)
- Remove R11
- Make R10 22k
- Replace C8 with wire link

- The 'X' connection is made to the capsule membrane termination
- The second capsule backplate termination is taken from the Voltage Multiplier output

- The High Pass Filter built around pins 5, 6 & 7 of IC1 is shown as a 2nd order Sallen-Key high pass filter, with a Chebyshev type response curve
- With the values shown the cut off (Fc) is c.80Hz
  The filter Q = 0.98 Damping ratio ζ = 0.5

OPIC.TX3 (regulated) Circuit description

Overview:

The circuitry shown in the schematic uses a Texas Instruments OPA1642 dual JFET op-amp. One op-amp is configured as a unity gain buffer, which acts as an impedance converter for a condenser microphone capsule.

The second op-amp includes a 2nd order Chebyshev high pass filter, which has a cut off frequency set to c.80Hz in the configuration shown in the schematic. This provides an alternative signal path with low frequency attenuation. This can be useful to help limit excess LF signal content which would otherwise be present at the transformer input.

The OPA164* series of op-amps offer both low noise and low quiescent current, making them ideal for this task. There is also no need for any bias adjustments to be included, which further simplifies construction.

The outputs from each op-amp are exclusively connected to a Neutrik transformer type NTE-1, to provide an isolated balanced audio output - via pins 2 and 3 of the XLR connector - to the attached mic preamp.

Circuit description:

The OPA1642 amplifiers are both configured as unity gain non-inverting buffers. The op-amp output is connected directly to the inverting input to achieve this.
Each amplifier draws around 1.8mA of quiescent current, and this is provided by the 48v phantom power supply from the mic preamp.
The resistor summing network R3 and R4, together with a 12v Zener diode ZD1 and the de-coupling capacitors C1 and C2, allow a smoothed supply voltage of 12v to be presented to pin 8 of the op-amp package.
Unlike versions of OPIC without pad options, where the values of R3 and R4 are selected to maximise headroom, the op-amp supply is regulated here to allow for accurate pad calibration.

The op-amp requires a 'dual' voltage supply, and this is provided by the creation of a 'half rail' voltage of 6v by the voltage divider R5 and R6, together with the decoupling capacitors C3 and C4.
This 'half rail' voltage is required to bias the op-amps, so that the output can swing symmetrically around this reference voltage.

The 'half rail' bias voltage is fed to the non-inverting input of the op-amps via R1 and R10.

R1 is a 1GΩ resistor. This extremely high value is necessary to maintain the electrostatic charge on the capsule diaphragm, which acts as a very small value 'variable' capacitor. A lower value resistor would result in a poor low frequency response. The connected op-amp is configured as a unity gain buffer amplifier, which acts as the impedance converter.

R10 is part of the Chebyshev high pass filter configured around the second amplifier. This resistor, along with the other filter components R11, C8 & C9 will create a 2nd order high pass filter, with a cut off frequency of c.80Hz.

The LDC capsule used in this microphone requires an externally generated polarising DC voltage. (See the voltage multiplier – 'VM' - schematic).
The 'X' input connection on the schematic is normally connected to the membrane capsule termination, the other (backplate) termination being connected to the DC output of the VM. Reversing these connections will reverse the polarity of the output, if that is required.

It is important to remember that the 'X' input is biased at positive 'half rail' (6v), and that DC value needs to be added to the calibrated voltage multiplier DC output, to determine the actual polarisation voltage that is applied to the capsule itself.

The primary 'full bandwidth' op-amp output (pin 1) is connected - via link 'A' - to R2 and C7, and then on to one end of the output transformer (TX1) primary winding. The other end of that winding is connected to 0v (gnd).
That same pin 1 output is also connected, via C8, to the Chebyshev high pass filter components assembled around the second op-amp. (C8, C9, R10 & R11.)
With link 'B' fitted, the output of this second op-amp (pin 7) provides an alternative high pass filtered signal to the transformer primary, again via R2 and C7.

The secondary winding is connected to pins 2 and 3 of the XLR connector, which provides a balanced output signal to the attached mic pre-amp.
R7 and R8 are included in series with the transformer secondary to allow for output impedance adjustments, if required. The indicated value of 47R is nominal, and can be changed to suit specific requirements if necessary.
R9 is included to minimise any high frequency 'ringing' that may be present at the transformer secondary output.
C5 and C6 are included to decouple any stray RF interference which may be present.

Mic Capsule: Centre terminal connection to IC1 pin3 and R1)

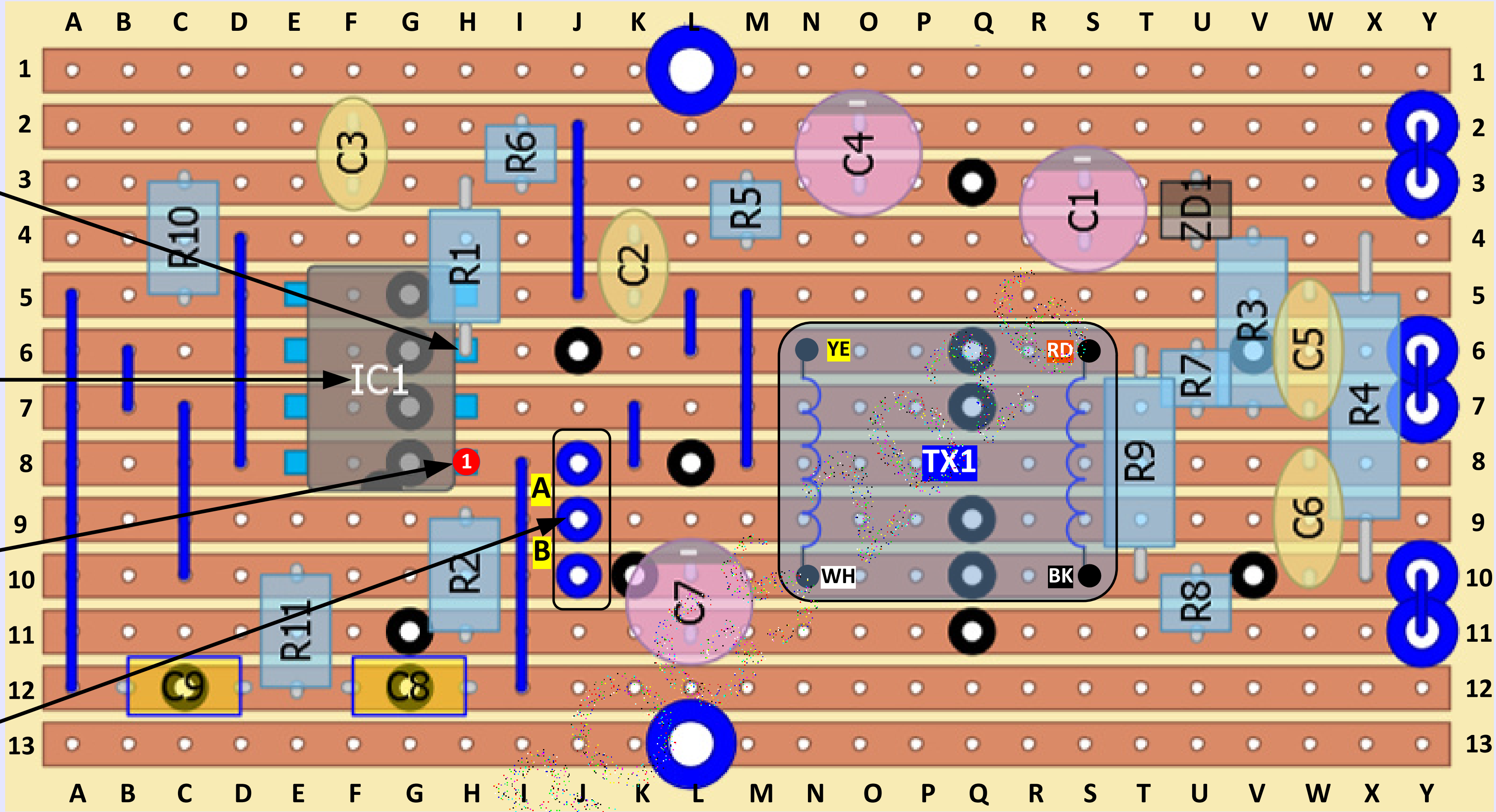
IC1 SOIC to DIP Adaptor : **DO NOT CONNECT PIN 3 TO STRIPBOARD**

NOTE IC1 Orientation PIN 1 to H8

FOR FULL SPECTRUM RESPONSE FIT LINK: **A**

FOR HIGH PASS RESPONSE FIT LINK: **B**

(High Pass Filter is 2nd order Butterworth with an Fc of c.72Hz)



1

2

3

Connections out to XLR

(Double padded for simpler track side termination)

OPIC.TX3(reg) – STRIPBOARD

- FC2 or FC4 (KEMO E005)
- 13 (copper tracked) rows
- 25 columns
- **VIEWED FROM COMPONENT SIDE •**

- L1 and L13 are mounting holes
- 12 x TCW links (marked as blue lines)
- 18 x 'spin off' track cuts (marked as black and white dots)

Fit the components listed below:

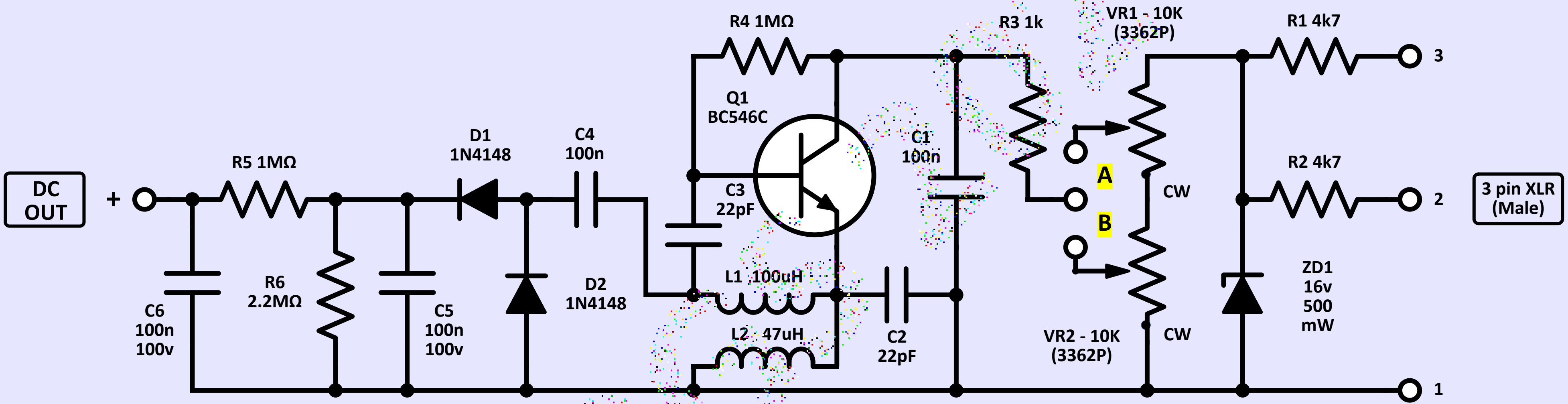
- C1 47uF 35V
- C2 100n 63V mlc
- C3 100n 63V mlc
- C4 47uF 35V
- C5 10n 63V mlc
- C6 10n 63V mlc
- C7 47uF 35V
- C8 100nF PET
- C9 100nF PET

- R1 1GΩ (10%) (RGP0207CHK1G0 or similar)
- R2 47R • R3 4k7
- R4 4k7 • R5 47k
- R6 47k • R7 47R
- R8 47R • R9 470R
- R10 33k • R11 15k

All resistors (except R1) are MF12 1/8th watt

- IC1 OPA16412 (via adaptor) **(Pin1 - H8)**
- ZD1 12v 500mW
- TX1 NTE-1 (Neutrik)

• OPIC.TX3: HARTLEY OSCILLATOR BASED ADJUSTABLE VOLTAGE MULTIPLIER •
• (WITH ADJUSTABLE PAD OPTION) •



To calibrate primary output:

- Fit link **A**
- Connect DMM between D1 cathode and 0v (ground)
- Adjust VR1 until required DC is measured on DMM
- (range is c.+40v to c.+95v)

To calibrate pad output:

- Fit link **B**
- Connect DMM between D1 cathode and 0v (ground)
- Adjust VR2 until required DC is measured on DMM

- *For -10dB pad set VR2 for 31.6% of primary voltage*
- *For -20dB pad set VR2 for 10% of primary voltage*

- ***Increase the value of both these calibrated voltages by +6v, to compensate for the op-amp half rail bias***

- *Fit link **A** or link **B** to apply the required capsule voltage*

- *Links can be replaced with an SPDT switch, if required*

Typical results with component values shown:

- **Primary Output Voltage: c.+30v to +95v** *(Adjust using VR1)*
- **Pad Output Voltage: 0v to c.+30v** *(Adjust using VR2)*
- Max volts: With VR1 and VR2 fitted as 3362P: • CW (CW= clockwise)
- Oscillator frequency: c. 2MHz
- Current: c. 2.5mA

OPIC.TX3 - Adjustable Voltage Multiplier

Overview:

The circuitry shown in this schematic is designed to generate a high voltage DC output – adjustable by a potentiometer (VR1) to provide a DC between c.45v and c.95v – which is applied as the polarisation voltage required to bias a conventional large diameter condenser microphone capsule.
Additionally, a second variable potentiometer (VR2) is fitted to allow for a second, lower DC voltage to be generated, providing the option for a adjustable preset attenuation 'pad' to be created. The addition of a simple link will reduce the polarisation voltage supplied to the capsule, and reduce the sensitivity of the microphone, when required.
DC power to the circuitry is supplied from the 48v phantom power of the attached mic pre-amp. About 3mA will be drawn by this circuit.

Circuit description:

This particular circuit is based on a Hartley oscillator, the sine wave output of which is AC coupled to a voltage doubling circuit, which produces the required positive high voltage.
There are a number of alternative possible configurations for a Hartley oscillator. The one chosen for this project follows the format used by Schoeps, in their famous 'CMC5' microphone schematic.

There are many online technical items on Hartley oscillators. The notes here:
https://learnabout-electronics.org/Oscillators/osc21.php
provide some interesting insights, particularly regarding mutual coupling of the inductors, which can play an important role in the layout of the oscillator components.

In this schematic, a Hartley oscillator running at c.2MHz is formed by the components connected to Q1. The amplitude of the oscillator output, which is taken from the junction of L1 and C3, will be a sine wave that will vary in amplitude between 0v and c.+95v (p-p), depending on the position of the calibration potentiometers.
Notice the positions of the 2 inductors L1 and L2 on the stripboard. Although not critical, it is recommended that the inductors are laid with the same orientation, in adjacent 0.1" stripboard rows. That should provide for an appropriate level of mutual inductive coupling between the inductors, for reliable oscillator operation.
R1 and R2 will feed both legs of the 48 v phantom power from the mic pre-amp to the cathode of ZD1. The regulated 16v DC supply from this point is fed - via the adjustable potentiometers VR1 or VR2 - to the collector of Q1.
C1 serves to decouple this supply.
The variable DC available at this point will determine the amplitude of the oscillator output, and the value of the final voltage multiplier output as a result.

The oscillator output is fed - via C4 - to the junction of D1 anode and D2 cathode. D1 and D2 - in conjunction with C4 and C5 - form a voltage doubling circuit, which will produce a positive rectified DC voltage of between c.45v and c.95v at D1 cathode, depending on the setting of VR1.
R6 is added as a nominal load, to ensure the output voltage will follow the pad link setting accurately.
R5 and C6 act as a low pass output filter, to allow a smoothed DC voltage to be present at the output terminal.
This DC output is connected to the backplate of the capsule.

Fitting link 'A' on the schematic will connect the wiper of VR1 to the collector of Q1 via R3. The position of VR1 wiper will determine the DC voltage applied to the oscillator collector. Adjusting VR1 will permit a positive DC voltage of between 45v and 95v to appear at the output terminal.

Fitting link 'B' will allow VR2 to become active. This will allow for a lower voltage of between 0v and c.35v to be generated at the output, thus providing a lower polarisation voltage across the capsule to reduce the sensitivity, where this is required.
Note that the A/B link can be replaced by a simple SPDT switch, if external control of the pad function is required.

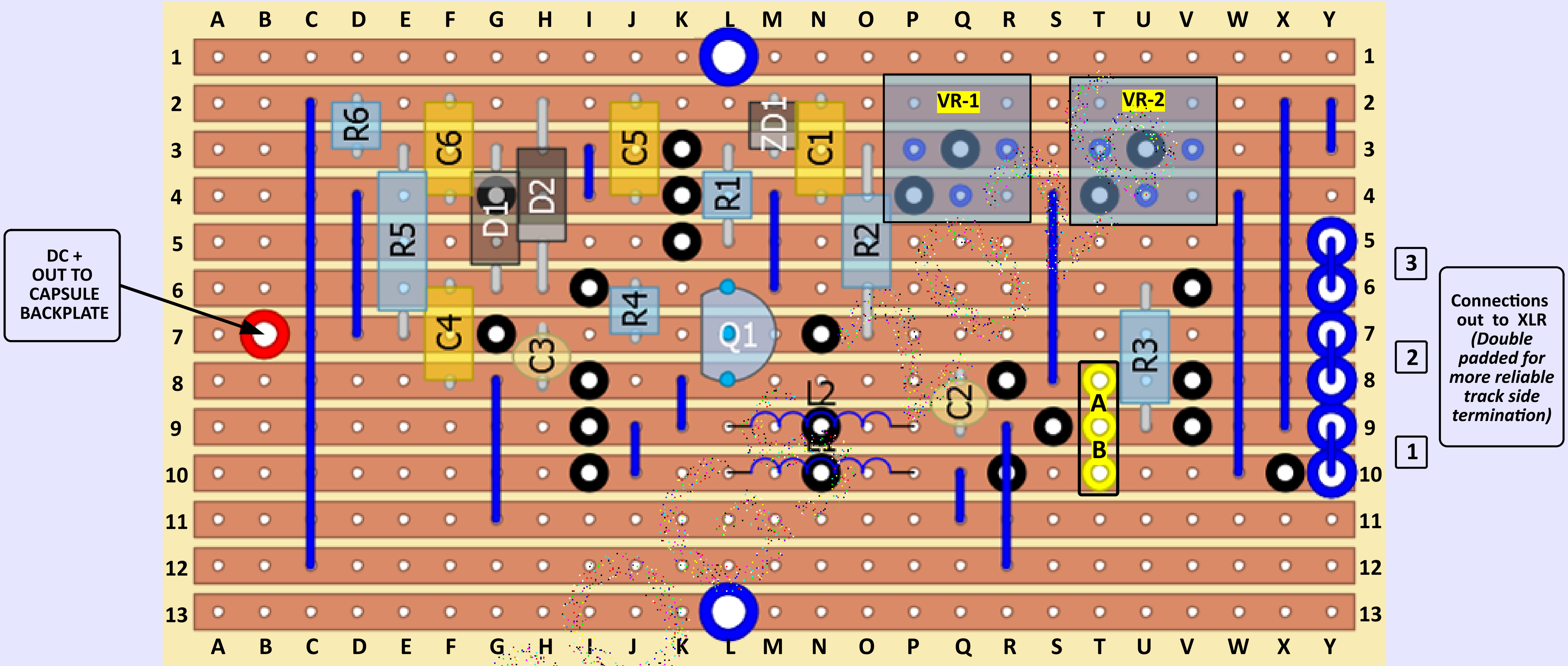
• Generating a voltage of 31.6% of the primary capsule voltage will allow for the sensitivity to be reduced by 10dB.
• Generating a DC of 10% of the capsule voltage will allow for a 20dB reduction in sensitivity.

Note that these calibrated output voltage values do not include the addition of the half rail voltage (6v), which needs to be added to the setting of both preset output voltages, to compensate for the reduction this 6v bias has on the voltage actually developed across the capsule.
• That 6v figure is a constant, so needs to be added to both output voltages AFTER those voltages have been calibrated.

The continuous adjustment option of VR2 will allow for any value of attenuation 'pad' in dB to be created, once the appropriate voltages have been calculated and applied.

Note that capacitors C4, 5 & 6 need to be rated at 100v rather than the more common 63v type that can apply to other capacitors in this circuit.

• To determine the actual value of DC being supplied to the output, it is recommended that DMM measurements are taken from D1 cathode, and not from the actual output termination itself. This will minimise the effect the impedance of the DMM has on the observed voltage readings.



OPIC.TX3 (R6 load)
Voltage Multiplier Stripboard

- FC2 or FC4 (KEMO E005)
- 13 (copper tracked) rows
- 25 columns
- L1 and L13 are PCB mounting holes
- 16 x TCW links (marked as blue lines)
- 25 x 'spin off' track cuts (marked as black and white dots)

• VIEWED FROM COMPONENT SIDE •

Fit the components listed below:

Capacitors

- C1 - 100n 100V PET
- C2 - 22p 63V mlc
- C3 - 22p 63V mlc
- C4 - 100n 100V PET
- C5 - 100n 100V PET
- C6 - 100n 100V PET

- *Resistors R1-R5 are MF12 metal film*
- *R6 is MF25 metal film*

- R1 - 4k7 • R2 - 4k7 • R3 - 1k
- R4 - 1M • R5 – 1M • R6 -2M2

- VR1 & VR2 10K *Bourns 3362P (or similar)*

- Q1- BC546C
- D1- 1N4148
- D2- 1N4148
- ZD1- 16V 500mW
- L1 - 100uH
- L2 - 47uH

L1 & L2 are Bourns 78F series (or similar)