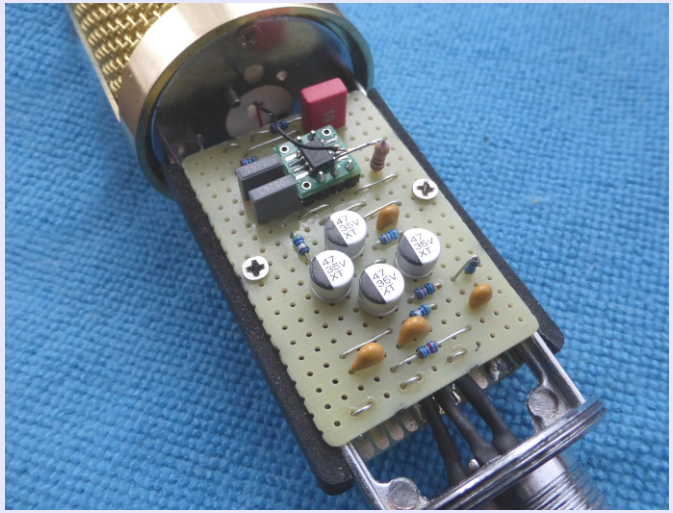
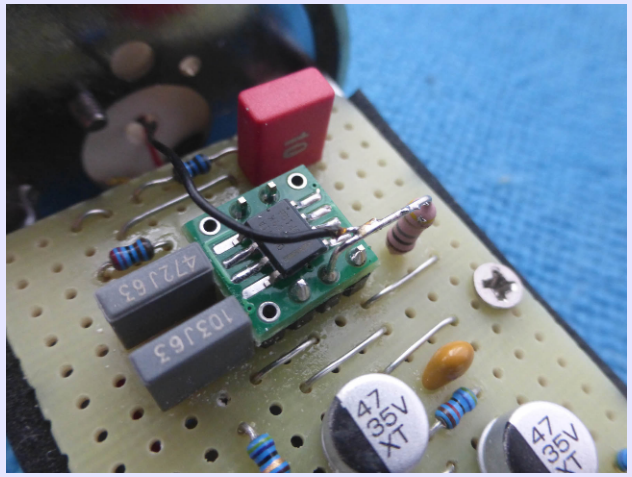
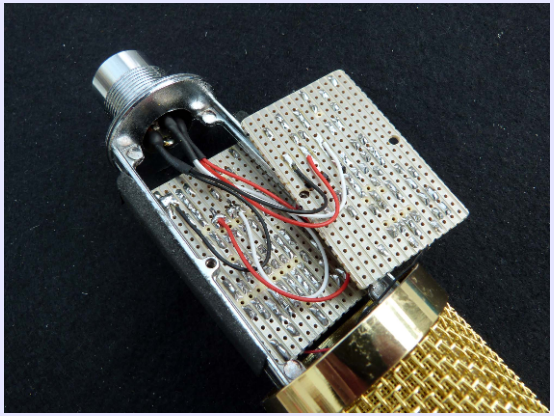
OPIC.EQ.2 OPA1641 Impedance Converter

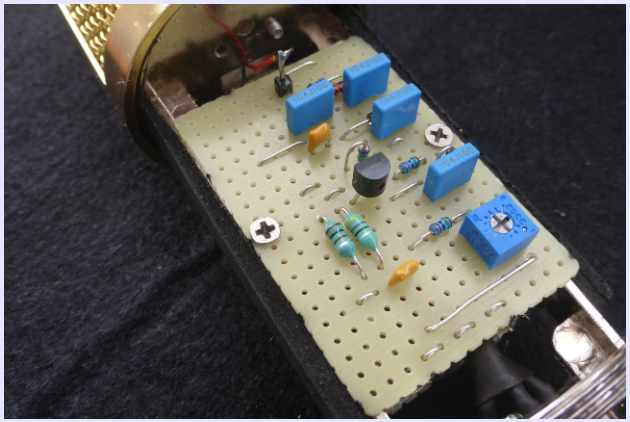
- Selectable EQ -- First order High Pass and Low Pass filters
- Adjustable Voltage Multiplier
- Designed to fit into a BM800 body

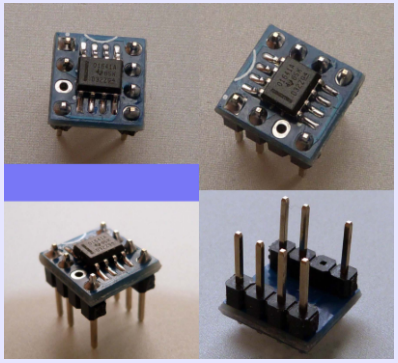
- *OPIC.EQ - Original spec -- See notes here:*
  https://www.jp137.com/lts/OPIC.EQ.pdf
- *OPIC.EQ.2 - C12 added for extra filter control*











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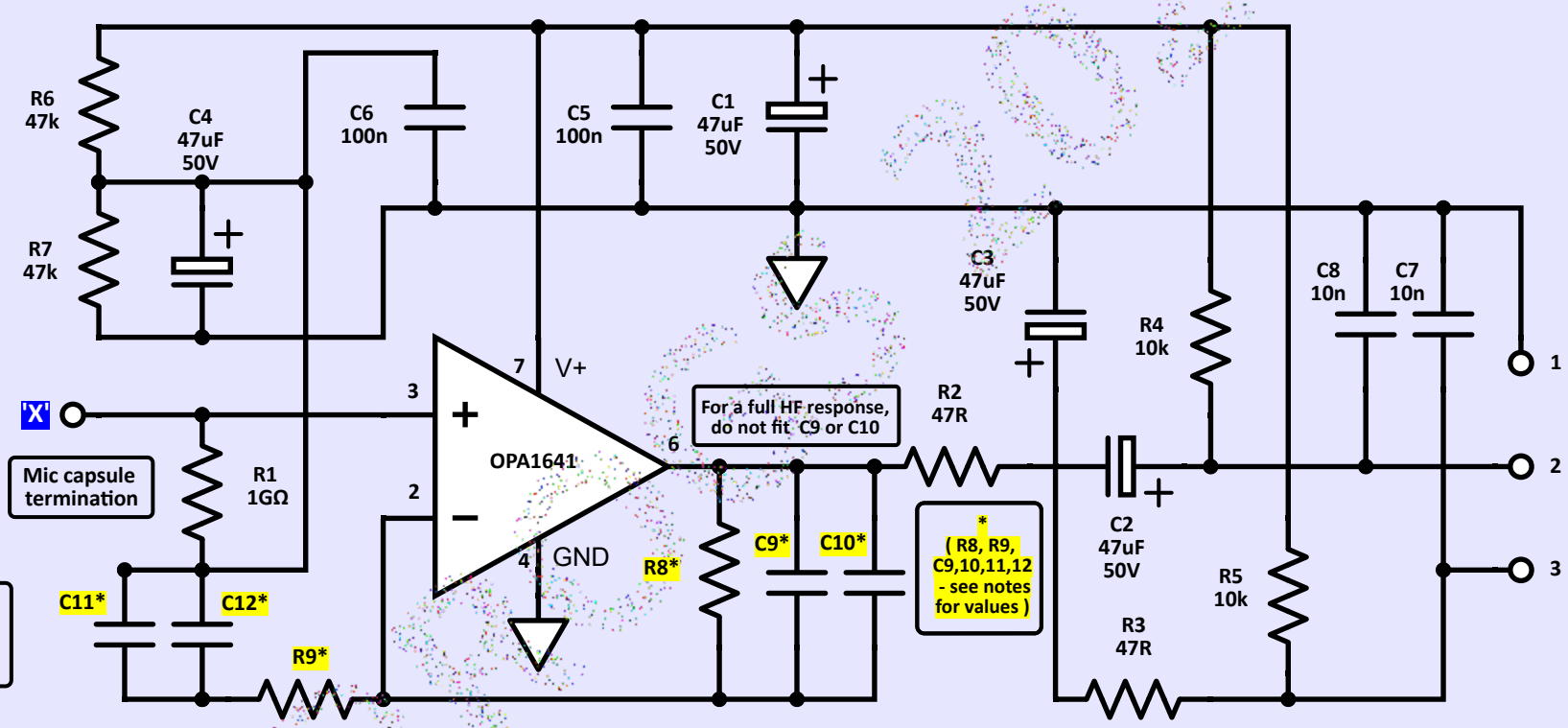
• *OPIC.EQ.2 - C12 added for extra filter control*

• OPIC.EQ.2 - Op Amp Impedance Converter (with adjustable EQ) •



- The 'X' connection is made to either one of the capsule terminations – normally the backplate.
- The second capsule connection is taken from the Voltage Multiplier output – normally to the membrane terminal.
- Note that reversing these connections will invert the polarity of the microphone output

• R8 & R9, C11, C12 - 1st order high pass filter (Fc = -3dB):

- R8:2k2, R9:2k2, C11:470n • Fc: 90Hz (45Hz: -4.6dB)
- R8:4k7, R9:2k2, C11:470n, C12: 100n • Fc: 100Hz (50Hz: -6dB)

Gain: • R8 & R9:2k2, gain is 2 (+6dB) • R8:2k2, R9:4k7, gain is c.3 (+10dB)

• R8, R9, C9 & C10 - 1st order low pass filter (Fc = -3dB)

- R8:2k2, R9:2k2, C9:10n, C10:4n7 • Fc: 7.5KHz (10Khz: -3.8dB, 15KHz: -4.75dB)
- R8:4k7, R9:2k2, C9:4n7, C10:1n • Fc: 7KHz (10Khz: -4.5dB, 14KHz: -6dB)

Note: With R8 fitted as 2k2, the gain is 2. When R8 is fitted as 4k7, the gain is 3, and the filter slopes become slightly steeper (-6dB @ 50Hz & 14KHz)

OPIC.EQ.2 Circuit description

Overview:
The circuitry shown in the schematic uses a Texas Instruments OPA1641 JFET op-amp as an impedance converter for a condenser microphone capsule.
The circuit offers a simple alternative to the more conventional use of a discrete JFET device to perform this function..
The OPA164* series of op-amps offers low noise, very low distortion, and low quiescent current, making them ideal for this task.
There is also no need for any separate bias adjustments to be included, which further simplifies construction.

A single OPA1641 op amp is used here to provide a single sided audio output. The overall circuit does however provide a balanced output. The line is impedance balanced passively, to help optimise the common mode rejection ratio (CMRR).

In addition, this version includes the option to introduce both high pass and low pass 1st order filters into the op-amp signal path. The high pass to allow for the attenuation of very low frequency signals (below c.90Hz) and a low pass filter to attenuate the often excessive high frequency output levels generated by many LDC capsules. The cut-off frequencies for both filters can be adjusted by selecting alternative components. A selection of values for suitable filters is included in the project schematic notes.

Circuit description:
The OPA1641 is configured as a non-inverting buffer amplifier, normally with a gain of 2 (6dB) or c.3 (c.10dB). The op-amp output is connected to the inverting input via resistor R8, which is selected to be either 2k2 - for a gain of 2 - or 4k7 for again of c.3.
R9 is fitted as 2k2 which, in conjunction with R8, enables the gain settings mentioned above. R8 is also connected to the AC signal ground (half rail), via the high pass coupling capacitors C11 and C12.

The 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 R4 and R5, together with the decoupling capacitors C1 and C5, will allow a smoothed supply voltage of around 20v to be presented to pin 7 of the op-amp.
The actual supply voltage is not critical, as the circuitry will automatically adjust the half rail reference to suit the supply voltage.
The op-amp requires a dual voltage supply, and this is provided by the creation of a 'half rail' voltage of around 10v by the voltage divider R6 and R7, together with the decoupling capacitors C4 and C6.

This 'half rail' voltage is required to bias the op-amp, so that the output can swing symmetrically around this reference voltage.
The voltage is fed to bias the non-inverting input of the op-amp via R1, the very high value 1GΩ resistor which works in series with the low capacitance value of the capsule, to form a high pass filter with a low Fc to enable a full range frequency response from the capsule

The LDC capsule used in this version requires an externally generated polarising DC voltage. (See the 'VM' schematic description for more details.)
The 'X' input connection on the schematic is connected to one capsule termination (normally the backplate) with the other being connected to the output of the VM voltage multiplier. The polarity of the microphone will depend on which capsule lead is connected to which termination.

It is important to remember that the 'X' input is biased at positive 'half rail' (c.10v), and that voltage needs to be added to any voltage multiplier DC output, to determine the actual polarisation voltage applied to the capsule.

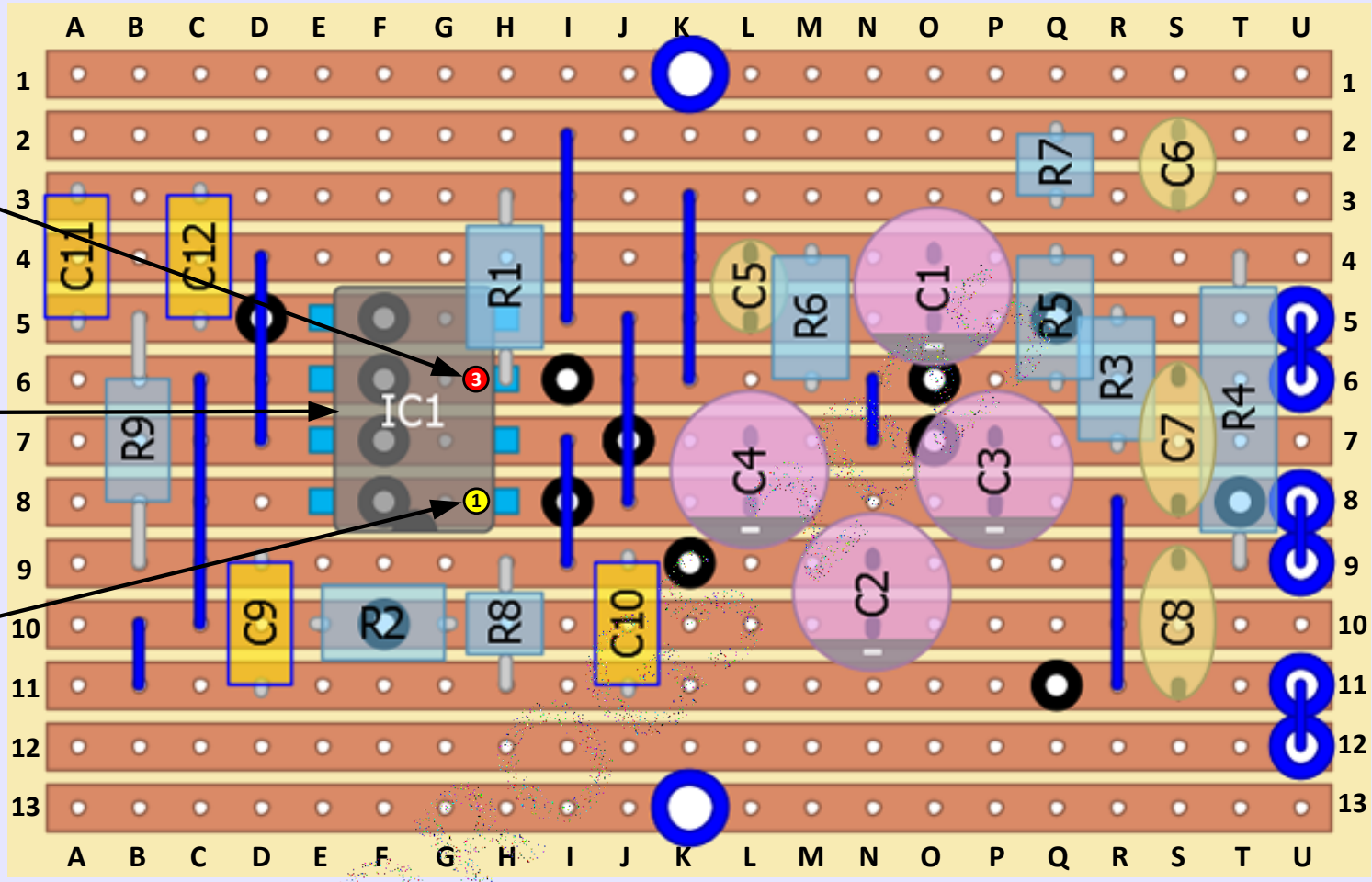
The op amp output (pin 6) is connected via R2 and C2 to pin 2 (hot) of the XLR connector. C2 is required to isolate the DC 'half rail' voltage present on the output of the op-amp from the XLR output.

R3 and C3 provide a passively impedance balanced output to pin 3 (cold) of the XLR connector. There is no audio on this pin. R3 and C3 are simply fitted to impedance balance the line.

The high pass filter components R9 and C12 are selected to attenuate low frequencies below c.100Hz (depending on the values selected), which often only serve to add unwanted low frequency ambient noise to the signal. (If the full range low frequency response is required, C11 may be replaced with a wire link).

The low pass filter components R8, C9 & C10 are selected to provide attenuation of excessive high frequencies at around 8 to 10KHz, which can be generated by many cheaper LDC capsules, especially those constructed in the K.67 style. The schematic shows a suggested list of values from which appropriate components can be selected to meet specific requirements. An Fc at around 7.5KHz is often a good starting value, when experimenting with a typical K.67 style capsule.

C7 and C8 are included to help de-couple any stray RF interference, which may be present on the XLR outputs, to ground



Connect mic capsule backplate termination to pin 3 & R1 (Above IC1)

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

NOTE: IC1 Orientation PIN 1 to F8

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- *OPIC.EQ.2 - C12 added for extra filter control*

3
2
1

Connections out to XLR

(Double padded for more reliable track side termination)

OPIC.EQ.2 – Stripboard

• VIEWED FROM COMPONENT SIDE •

- FC2 or FC4 (KEMO E005)
- 13 (copper tracked) rows
- 21 columns

- K1 and K13 are PCB mounting holes
- 12 x TCW links (marked as blue lines)
- 15 x 'spin off' track cuts (marked as black and white dots)

Fit the components listed below:

Capacitors:

- C1 47uF 50v elec
- C2 47uF 50v elec
- C3 47uF 50v elec
- C4 47uF 50v elec
- C5 100n 63v mlc (0.1")
- C6 100n 63v mlc (0.1")
- C7 10n 63v mlc (0.2")
- C8 10n 63v mlc (0.2")
- C9 SAR 63v PET (0.2")
- C10 SAR 63v PET (0.2")
- C11 SAR 63v PET (0.2")
- C12 SAR 63v PET (0.2")

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

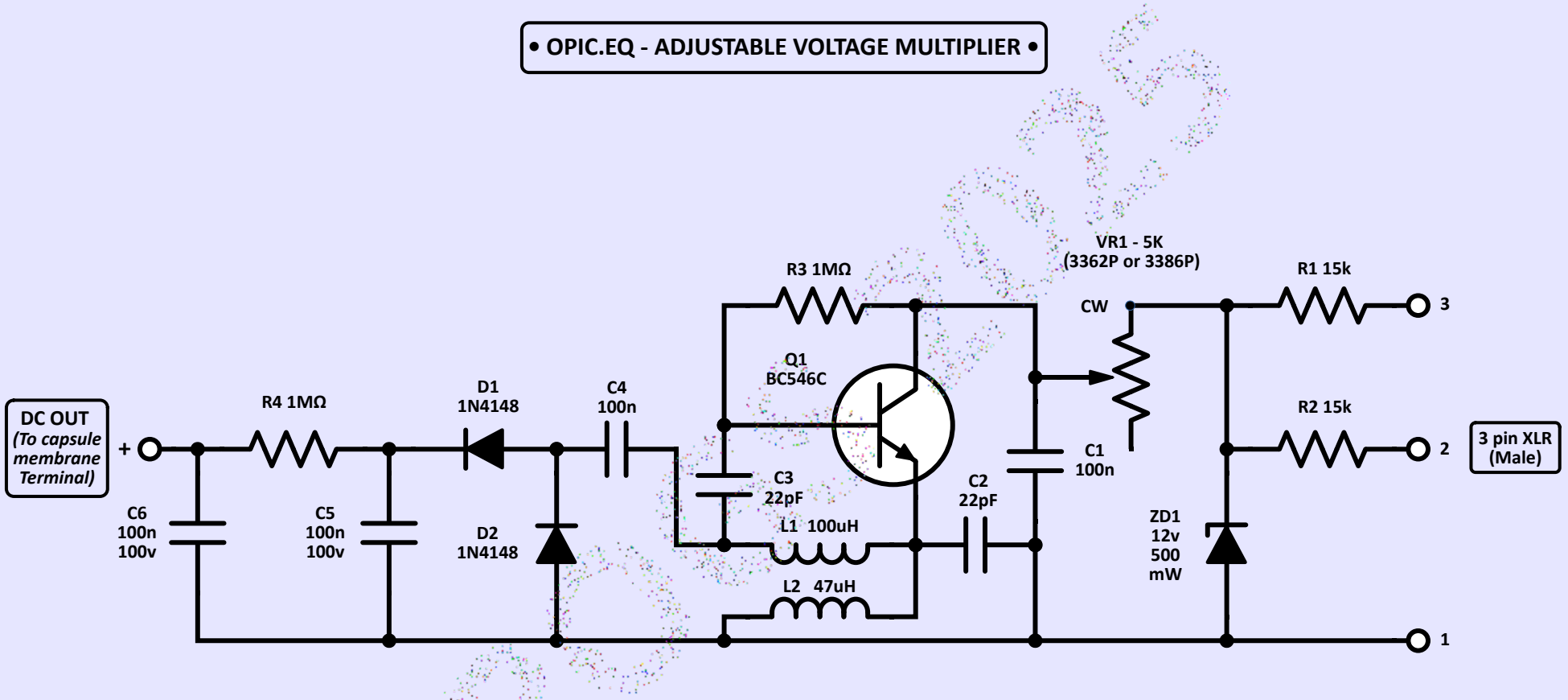
- R1 1GΩ (10%) *(RGP0207CHK1G0 or similar)*
- R2 47R
- R3 47R
- R4 10k
- R5 10k
- R6 47k
- R7 47k
- R8 2k2
- R9 2k2

<< 'SAR' = 'select as required' (see schematic)

Semiconductors:

- IC1 OPA1641 (via adaptor) **(Pin 1 - F8)**

• OPIC.EQ - ADJUSTABLE VOLTAGE MULTIPLIER •



Typical results with component values shown:

- **Output voltages: c. +45v to +90v** *(Adjust using VR1)*
- Max volts: CW 3362P or CCW 3386P (CW= clockwise)
- Oscillator frequency: c. 2MHz
- Current: c. 2.5mA

OPIC.EQ - Adjustable Voltage Multiplier

Overview:

The circuitry shown in this schematic is designed to generate a high voltage DC output – adjustable between c.45v and c.90v – to be applied as the polarisation voltage to a large diameter condenser microphone capsule.

DC power to the circuitry is supplied from the 48v phantom power of the attached mic pre-amp. About 2.5mA 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 c. 45v and c. 90v (p-p), depending on the position of the calibration potentiometer VR1.

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.

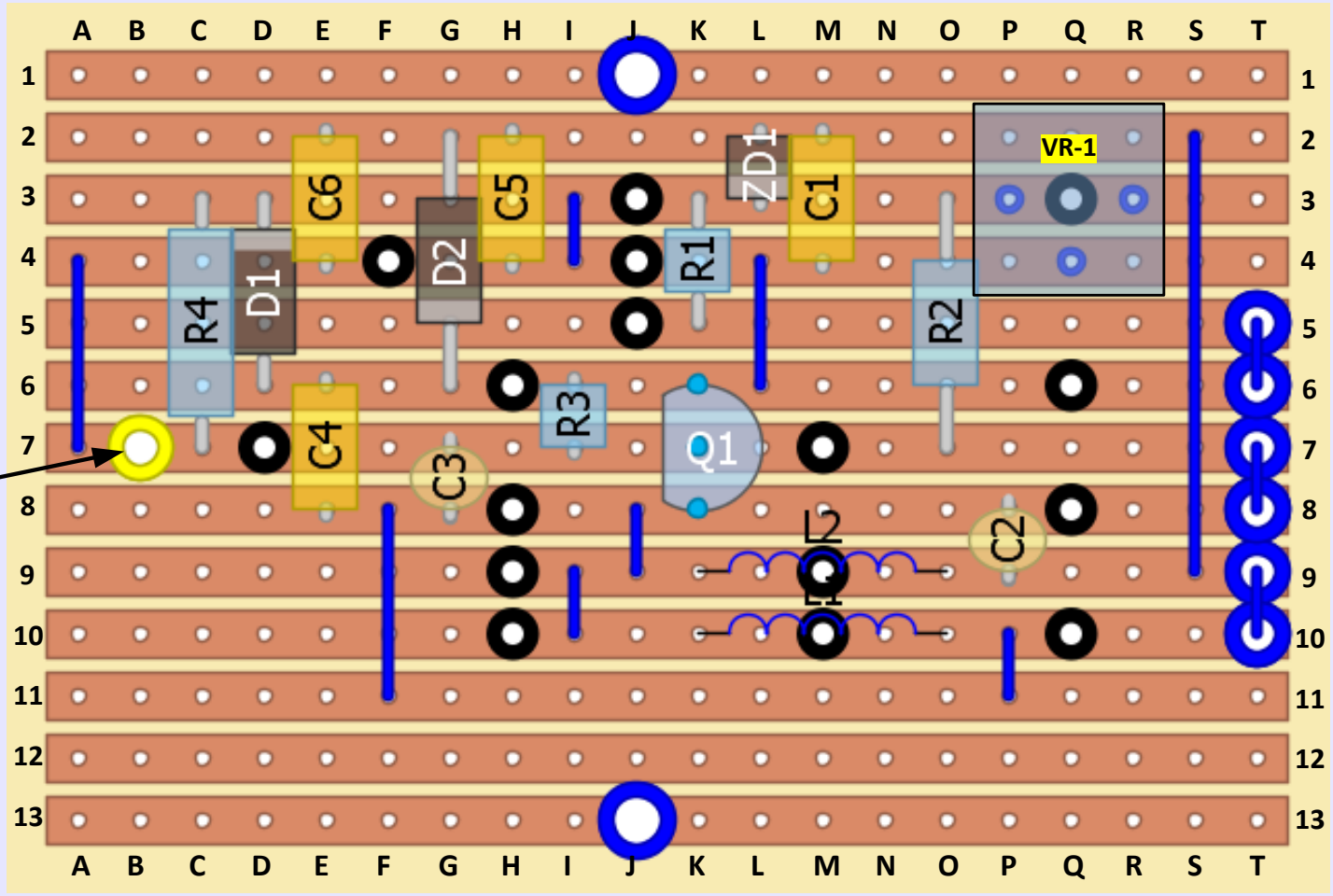
R1 and R2 will feed both legs of the 48 v phantom power from the mic pre-amp to the cathode of ZD1. The regulated 12v DC supply from this point is fed - via the adjustable potentiometer VR1 - to the collector of Q1.
C1 serves to decouple this supply. The variable DC available at this point will determine 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 rectified DC output of between +45v and +90v at D1 cathode, depending on the setting of VR1.

R4 and C6 act as a low pass filter, to allow a smoothed DC voltage to be present at the output terminal. This DC output is connected to backplate of the capsule.

Note that this DC output voltage does not include the positive value of the op-amp 'half rail' voltage, which needs to be added to the adjustable output voltage, to compensate for the reduction this 'half rail' DC has on the voltage actually developed across the capsule.

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.EQ Voltage Multiplier

Complete stripboard component layout

• VIEWED FROM COMPONENT SIDE •

- FC2 or FC4 (KEMO E005)
- 13 (copper tracked) rows
- 20 columns

- J1 and J13 are PCB mounting holes
- 11 x TCW links (marked as blue lines)
- 16 x 'spin off' track cuts
  (marked as black and white dots)

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

All resistors are MF12 1/8th watt:

- R1 15k
- R2 15k
- R3 1M
- R4 1M

- VR1 5K
  Bourns 3362P or 3386P
  (or similar)

Semis and inductors:

- Q1 BC546C
- D1 1N4148
- D2 1N4148
- ZD1 12V 500mW
- L1 100uH
- L2 47uH
  Bourns 78F series
  (or similar)