Stepped Pots for 3 Band Pultec

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Introduction

I have had several requests for details of how to convert my 3 Band Pultec EQ design to use stepped pots. This document provides details of how to do this using 1 pole 12 way switches to provide EQ boost or cut in 1dB steps from 0dB to 11dB.

The 3 Band Pultec passive EQ essentially consists of a simple potential divider formed from a 47K potentiometer and a 4K7 potentiometer. The EQ therefore has a nominal insertion loss of 4.7/(4.7+47) = 20.83dB

High Boost

High boost is achieved by frequency selectively shorting out some or all of the 47K potentiometer. Initially I calculated the exact values required to make a stepped 47K pot with 11 steps of 1dB. As expected, some very odd values occurred, so attempted to rationalise them all to standard E24 values. This was possible but it changed the total to 46.9K. So I recalculated all the attenuations using this total and the E24 resistor values. The table below shows the error at each boost position of the switch.

Boost dB	Error dB
0	-0.02
1	-0.01
2	-0.04
3	0
4	+0.02
5	+0.01
6	-0.04
7	0
8	+0.05
9	+0.07
10	+0.08
11	-0.08

In all cases the error is less than 0.1dB. To put this into context, these calculations do not account for the value of QMAX or the resistance of the inductor (which varies with which frequency is selected) which will introduce an additional small systematic error. The table below shows the exact calculated resistor values alongside their E24 preferred values.

Exact Value	E24 Value
5622	5K6
5011	5K1
4466	4K3
3980	3K9
3547	3K6
3162	3K3
2818	2K7
2511	2K4
2238	2K2
1995	2K0
1778	1K8
9871	10K
Total = 47K00	46K9

To account for QMAX (470 ohms) and the average resistance of the VTB9042 inductor (40 ohms), you can subtract 510 ohms from the final 10K resistor making it 9490 ohms. This can be made from 9K1 resistor in series with a 390 ohm resistor.

Hi Cut

The High Cut pot is the bottom arm of the divider used for High Boost so for High Boost to be correct, this needs to total exactly 4700 ohms. The table below gives the preferred resistor value for each step and the error. Note that the final resistor has to be made from two preferred values in series.

Loss dB	Resistor	Error dB
0	560	-0.0.1
1	470	-0.02
2	430	-0.05
3	360	-0.04
4	330	-0.08
5	300	-0.09
6	270	-0.05
7	220	+0.01
8	200	-0.01
9	180	0
10	150	+0.01
11	1200 + 33	0

Once again, all the errors are less than 0.1dB

Low Boost

The Low Boost resistor sits under the 4700 ohms of the High Cut and thereby reduces the attenuation at low frequencies. The table below lists the preferred values for each step along with the error:

Loss dB	Resistor	Error dB
0	0	0
1	6K8	0
2	7K5	0.03
3	8K2	0.07
4	10K	0.03
5	11K	0.01
6	12K	0.02
7	13K	0.06
8	15K	0.07
9	18K	0.02
10	20K	-0.02
11	22K	-0.04

Again, the errors are all below 0.1dB

Mid Boost/Cut

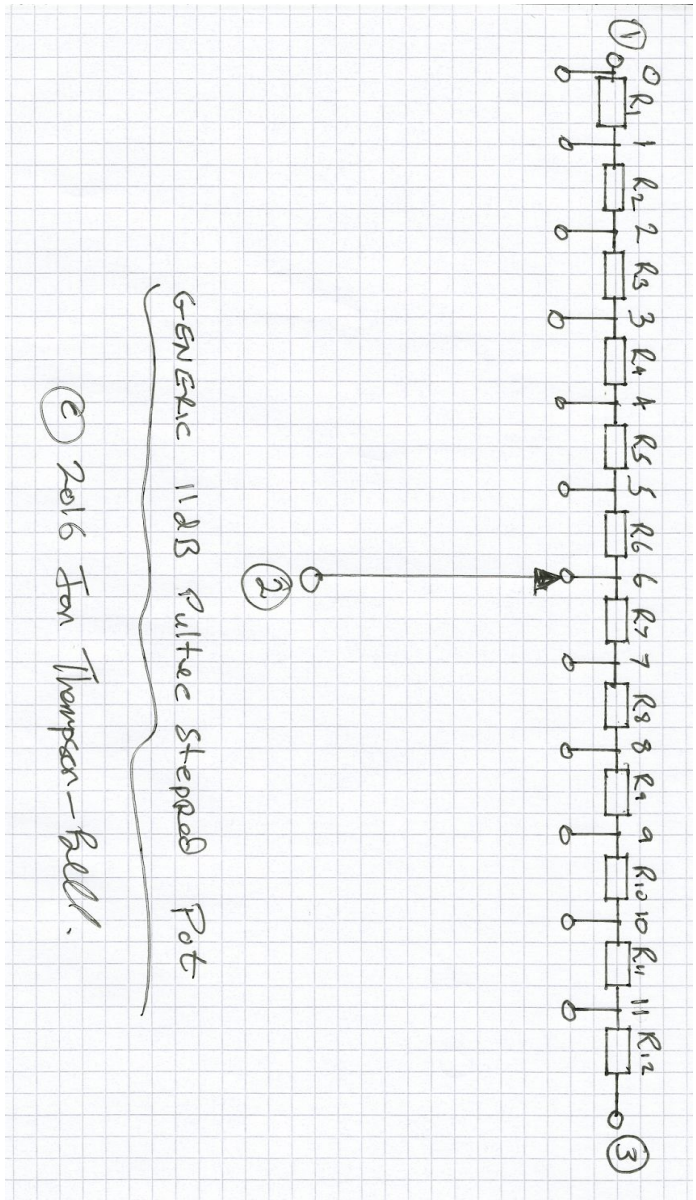
The mid boost/cut circuit works differently to the other sections of the EQ. The mid boost is in parallel with the 47K that forms part of the High Boost and, when switched to mid cut, it is in parallel with the 4K7 that forms part of the High Cut section of the EQ. There is also a fixed series resistor of 4K7 in the boost position and one of 1K in the cut position. For these reasons, the resistance required for a given mid boost will likely not produce the same amount of cut. The table below shows the preferred resistor values between each step required for boost and for cut and the actual values of boost and cut obtained:

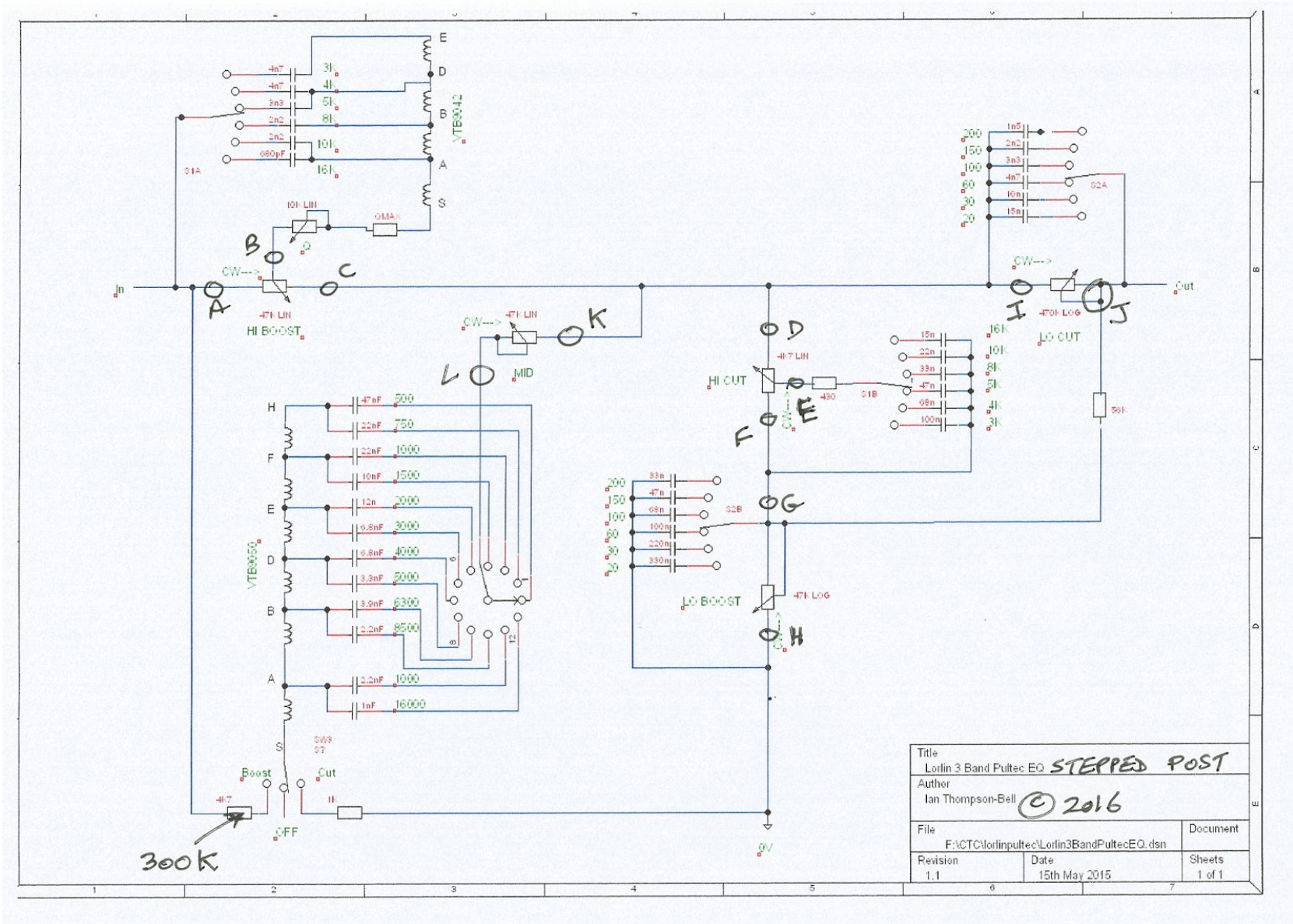
Boost R	**Boost dB**	**Cut R**	**Cut dB**
Open circuit	0	Open circuit	0
180K	1.01	18K	1.01
62K	2.00	6K2	2.01
30K	3.02	3K0	3.02
18K	4.02	1K8	4.02
12K	5.02	1K2	5.03
8K2	6.04	820	6.04
6K2	7.02	620	7.03
4K7	8.02	470	8.03
3K9	9.02	360	9.02
3K0	10.07	300	9.99
7K5	11.10	680	10.99

This table demonstrates that the resistors required for cut are about one tenth the value of those required for boost which is not surprising because the basic attenuator of the EQ consists of a 47K resistor and a 4K7 resistor. It is therefore not possible for a single set of resistor values to work for both cut and boost.

Implementation

The schematic overleaf shows the original 3 Band Pultec with the connections to each pot labeled - so for example, the High Boost pot leads are labelled A, B and C. The picture below shows a generic 12 way switch with resistors R1 to R12. and connection points 1,2 and 3. The tables that follow show how the switch points correspond to the letters of each pot and the values of R1 through R12 for each switch.




In
Out
CW--->
47K LIN
HI BOOST
MID
4K7 LIN
HI CUT
470R
S1B
47K LOG
LO CUT
56K
S2A
S2B
LO BOOST
VTB9042
VTB9050
S1A
10K LIN
QMAX
Q
SW3
S7
Boost
Cut
4K7
OFF
300K
0V
Title
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Revision
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Sheets
1 of 1

High Boost

- A connects to 1
- B connects to 2
- C connects to 3

Resistor values are:

Reference	Value
R1	5K6
R2	5K1
R3	4K3
R4	3K9
R5	3K6
R6	3K3
R7	2K7
R8	2K4
R9	2K2
R10	2K0
R11	1K8
R12	10K

Note R12 can optionally be replaced by a 9K1 plus 390R to compensate for QMAX and the inductor resistance.

High Cut

- D connects to 3
- E connects to 2
- F connects to 1

Resistor values are:

Reference	Value
R1	560
R2	470
R3	430
R4	360
R5	330
R6	300
R7	270
R8	220
R9	200
R10	180
R11	150
R12	1K2 + 33

Note, R12 is 1K2 in series with 33R. The 430R resistor is series with E is not required.

Low Boost

- G connects to 2 and 3
- H connects to 1

Resistor Values are:

Reference	Value
R1	620
R2	750
R3	820
R4	1K
R5	1K2
R6	1K3
R7	1K5
R8	2K
R9	2K2
R10	2K7
R11	3K3
R12	zero

Note R12 is not required.

Low Cut

- I connects to 1
- J connects to 2 and 3

Resistor Values are:

Reference	Value
R1	6K8
R2	7K5
R3	8K2
R4	10K
R5	11K
R6	12K
R7	13K
R8	15K
R9	18K
R10	20K
R11	22K
R12	zero

Note R12 is not required.

Mid Boost/Cut

- K is connected to 1 and 2
- L is connected to 3

Different resistor values are required for boost and cut so a two pole 12 way switch will be required. The SPST centre of toggle switch used to select Boost/Off/Cut will need to be changed to a DPDT version, one for each pole of the 12 way switch. So that only one set of resistors is connected at any time. Resistor values are:

Reference	Boost Value	Cut Value
R1	Open circuit	Open circuit
R2	180K	18K
R3	62K	6K2
R4	30K	3K
R5	18K	1K8
R6	12K	1k2
R7	8K2	820
R8	6K2	620
R9	4K7	470
R10	3K9	360
R11	3K0	300
R12	7K5	680

Note: in the 0dB position, the resistor network is completely disconnected.

Don’t forget the additional 4K7 fixed resistor in the boost position and the 1K resistor in the cut position.

Issue Record

0.1. Initial Issue 31st July 2016
0.2. Corrected Mid Boost/Cut 3rd August 2016