STEP BY STEP
CONSTRUCTION MANUAL

FOR THE

VANDERVEEN

VALVE PRE-AMPLIFIER

MCML05

Ir. Menno van der Veen

GENERAL INFORMATION

SUPPLIER
Amplimo b.v. is the official supplier of this kit in Europe. Amplimo b.v. also handles all contacts with the customers and users of the kit.

CONSTUCTION MANUAL
This manual is not available in bookshops; it is only available with the MCML05 construction kit.

SERVICE
Service from Amplimo b.v. consists of two elements:
a) Answering of questions by telephone, fax or email.
b) Checking and adjustment of the buyer's constructed amplifier for a charge of € 150 incl. VAT but excl. shipping charges. Please ensure that the amplifier is well packed before sending it to: AMPLIMO b.v.; Industrieweg 14; NL-7161 BX NEEDE, The Netherlands.
After inspection and repair, the amplifier will be returned, cash on delivery (shipping charges plus € 150.00) or after a prepayment. Shipping is at the risk of the customer. Inspection and repair will take a maximum of two weeks. The customer will be notified if it takes longer.

GUARANTEE
1) Guarantee conditions and terms of delivery are defined in the "Algemene Voorwaarden voor de Instrumentenbranche".
2) The guarantee period is a total of 6 months from the date of purchase, (see below).
3) All elements of the construction kit fall under these guarantee conditions. The guarantee does not cover destruction or damage by misuse. This is determined exclusively at the discretion of Amplimo b.v.

The following example clarifies this:
Every transformer is thoroughly checked before delivery. If it is found that the transformer is defective, Amplimo b.v. could conclude that the damage has been caused by misuse. For instance: by shortening the leads of the transformer (which you shouldn't do) or damage due to incorrect positioning of a valve in its socket. Because we are dealing with a DIY construction kit, damage is possible if the construction guidelines are not followed in full. The guarantee does not cover damage if it is due to faulty construction.

TERMS OF DELIVERY
1) The MCML05 amplifier is only sold as a complete construction kit, inclusive of the construction manual.
2) Individual components for the kit will only be supplied for the replacement of defective or incorrectly supplied parts, to the original owners of the kit.
3) Delivery will only take place after the purchase price has been paid in cash, in advance into the international bank account of Amplimo b.v. (IBAN NL 36 RABO 031311250), by cash on delivery or by payment using VISA or MasterCard. If you want to personally collect the construction kit please contact Amplimo b.v. first.
4) Acceptance by the buyer only takes places when the buyer has taken notice of the safety instructions on the following page of this manual.
5) Amplimo b.v. and Ir. buro Vanderveen will not entertain any claim, under any circumstance, if it is the result of not or only partially following the safety and building instructions.
6) In addition to the above, the General Terms of Delivery for the "Instrumentenbranche of the FHI" are applicable

SAFETY INSTRUCTIONS

1) This construction kit employs high voltages (220/230 Volt 50 Hz AC and 200 Volt DC). These voltages are potentially lethal if they come in contact with the human body. This is why you must take the greatest care to avoid accidents or damage of any kind.
2) Only work on the opened amplifier cabinet after the mains plug has been removed from the mains socket AND after the amplifier's high voltage supply has been discharged by first switching the amplifier to the off mode for several minutes.
3) Never work with both hands placed in the amplifier at the same time when it is switched on, or when there is still a high voltage present in the set. This situation is extremely dangerous, as leakage or discharge currents may flow from hand to hand via the heart.
4) Only use the prescribed fuses.
5) Take care to ensure that all high voltage leads are insulated and positioned far away from metal parts.
6) DO NOT SHORTEN THE LEADS OF THE TRANSFORMER as this can cause irreparable damage to the transformers.
7) Do not insert conductive objects into the cabinet.
8) Thoroughly check that the electrolytic capacitors are mounted as instructed, take care not confuse the negative pole with the positive pole, as this could cause acid to leak or for the capacitor to explode.
9) Thoroughly check that transformer leads are connected to the PCB and other parts in accordance with their prescribed colour scheme.
10) Ensure that valve sockets are mounted the right way round in accordance with the diagram.
11) When switching on for the first time explicitly follow the "test procedure" given for the completed set.
12) On the following pages you will find the so called "EG-verklaring van overeenstemming" with explanations. <u>To meet the terms of this declaration, the constructor has to follow ALL directions and conditions</u>.
13) Make sure that there is sufficient room around the amplifier for <u>ventilation</u>; at least 3cm is required each side and 10cm above. Take care to prevent any <u>fluids</u> from entering the amplifier. If this happens, immediately disconnect the set from the mains supply and send the amplifier to Amplimo to be checked. Also note that the cover located above the valves will become warm. <u>Take care at all times to prevent the cover from being touched</u> (paying special attention to children). Again with children in mind, position the amplifier so <u>that it becomes impossible to poke metal objects into the cabinet</u>.
14) This amplifier has to be earthed – ensure that the mains socket has an earth connection.
15) With soldered joints, hook the wire in place to form a mechanically stable joint before soldering. This ensures that the wire cannot become loose to cause potential damage or to become a hazard. A piece of heatshrink sleeving around this type of joint not only prevents you from touching the bare terminal, but is also gives extra protection against the contact from working loose.
16) Where two or more wires are soldered in close proximity to each other on the PCB or for instance on the volume control, they have to be secured in place by the use of a cable tie. This prevents the wires from drifting around in the cabinet if they accidentally become unsoldered.

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For possible future modifications:
www.mennovanderveen.nl

EG verklaring

INTRODUCTION

Dear buyer,

Thank you for buying the MCML05 valve pre-amplifier. This pre-amplifier was born out of the love for music, faithful music reproduction and exceptional spatial image. This pre-amplifier is based on many years of experience and study by the designer. The latest techniques and knowledge are used in this design. Some of the details are outlined below:

While designing this pre-amplifier it soon became clear that a really good pre-amplifier has to meet very high demands. The absence of noise and hum are well known conditions. These have been met, together with a vast frequency range and low distortion.

It was much harder though to correctly reproduce the “emotions” which are apparent in good music recordings. Reproduction of these emotions in particular requires a first-rate design and high quality components. It took several years of testing to ensure that this design and the choice of components could guarantee faithful reproduction of these emotions under all circumstances. The key prerequisite of these extensive tests had to be the evaluation of our ability to hear. “Do we experience the same sound quality as we will tomorrow, or is the sound quality equal to yesterdays sound quality”? We are convinced that this pre-amplifier, provided has been built carefully, will meet these high demands.

*One of the new features concerns the power supply. This automatically controls the increase of filament supply in 15 seconds from zero to the final value. The same applies to the high voltage supply, which will reach its stabilized value in approx. 30 seconds.
The switching on of this pre-amplifier happens in such a smooth & controlled way that we have omitted the now superfluous stand-by mode.*

We gave the pre-amplifier a separate output on the front panel to satisfy headphone users.

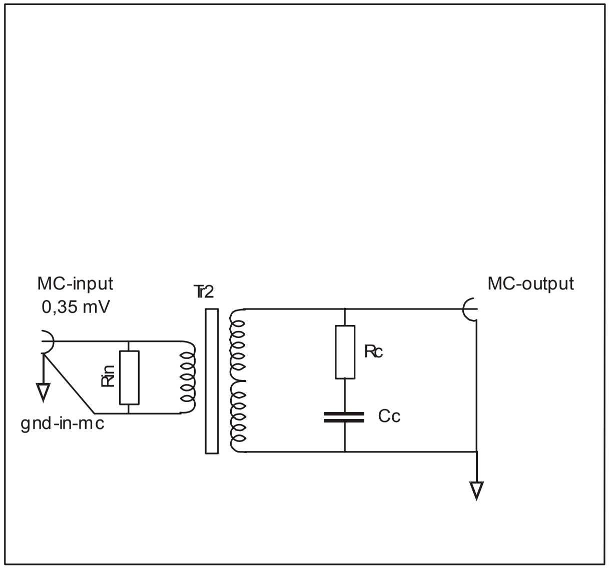
In addition to the usual line inputs this pre-amplifier also offers RIAA corrected inputs for moving magnet and moving coil pick up cartridges.

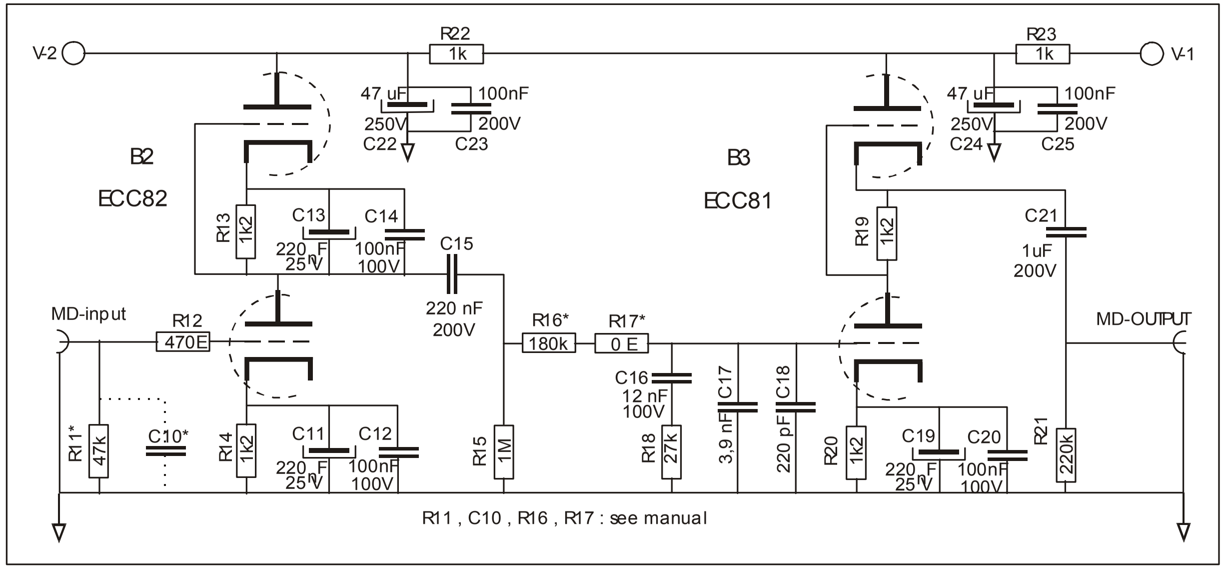
This pre amplifier consists of several modules: the line amplifier, the phono pre-amp (with passive RIAA correction), the MC pre-stage (supplied with Vanderveen MC-10 step up transformers) and the power supply. These are built on separate PCB’s, providing the opportunity to exchange each of these modules with one of alternative design. Whether these alternative modules are your own or designed by us doesn’t matter, the modular design of the pre-amplifier enables you to easily modify it. Just exchange a single PCB. Please visit the Vanderveen website for available updates and modifications.

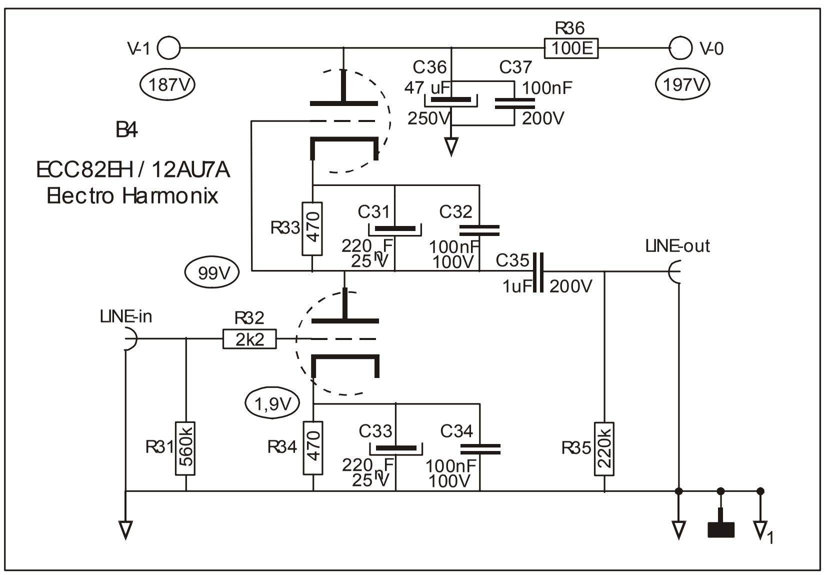
We hope that you will get lot of pleasure from building this MCLM05 valve pre-amplifier together with a greater joy in listening to your favourite music using this pre-amplifier. Should you have any questions, please contact our customer support department.

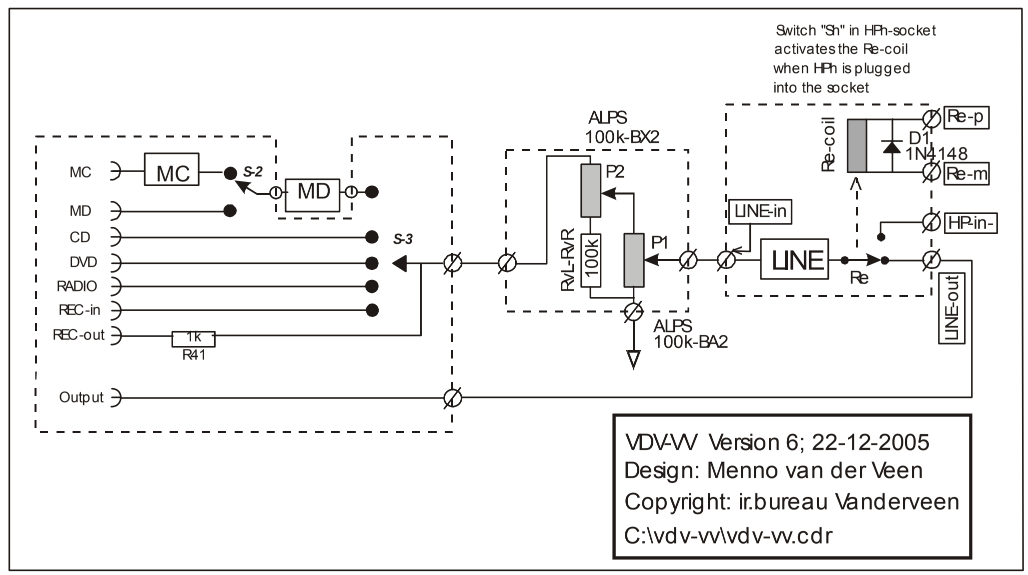
Ir. bureau Vanderveen b.v.
ir. Menno van der Veen
Nederland, november 2007

Amplimo b.v.
Hans Braam and Henk te Selle
Neede, november 2007


MC-input
0,35 mV
Tr2
Rin
gnd-in-mc
Rc
Cc
MC-output


V-2
R22
1k
R23
1k
V-1
47 uF
250V
C22
100nF
200V
C23
47 uF
250V
C24
100nF
200V
C25
B2
ECC82
B3
ECC81
R13
1k2
C13
220 uF
25 V
C14
100nF
100V
C15
220 nF
200V
MD-input
R12
470E
R16*
180k
R17*
0 E
C16
12 nF
100V
C17
3,9 nF
C18
220 pF
R19
1k2
C21
1uF
200V
MD-OUTPUT
R11*
47k
C10*
R14
1k2
C11
220 uF
25 V
C12
100nF
100V
R15
1M
R18
27k
R20
1k2
C19
220 uF
25 V
C20
100nF
100V
R21
220k
R11 , C10 , R16 , R17 : see manual


V-1
187V
R36
100E
V-0
197V
C36
47 uF
250V
C37
100nF
200V
B4
ECC82EH / 12AU7A
Electro Harmonix
R33
470
C31
220 uF
25 V
C32
100nF
100V
C35
1uF
200V
99V
LINE-out
LINE-in
R32
2k2
1,9V
R31
560k
R34
470
C33
220 uF
25 V
C34
100nF
100V
R35
220k


Switch "Sh" in HPh-socket
activates the Re-coil
when HPh is plugged
into the socket
ALPS
100k-BX2
P2
P1
RvL-RvR
100k
ALPS
100k-BA2
MC
MD
CD
DVD
RADIO
REC-in
REC-out
Output
S-2
S-3
1k
R41
LINE-in
LINE
Re
Re-coil
D1
1N4148
Re-p
Re-m
HP-in-
LINE-out
VDV-VV Version 6; 22-12-2005
Design: Menno van der Veen
Copyright: ir.bureau Vanderveen
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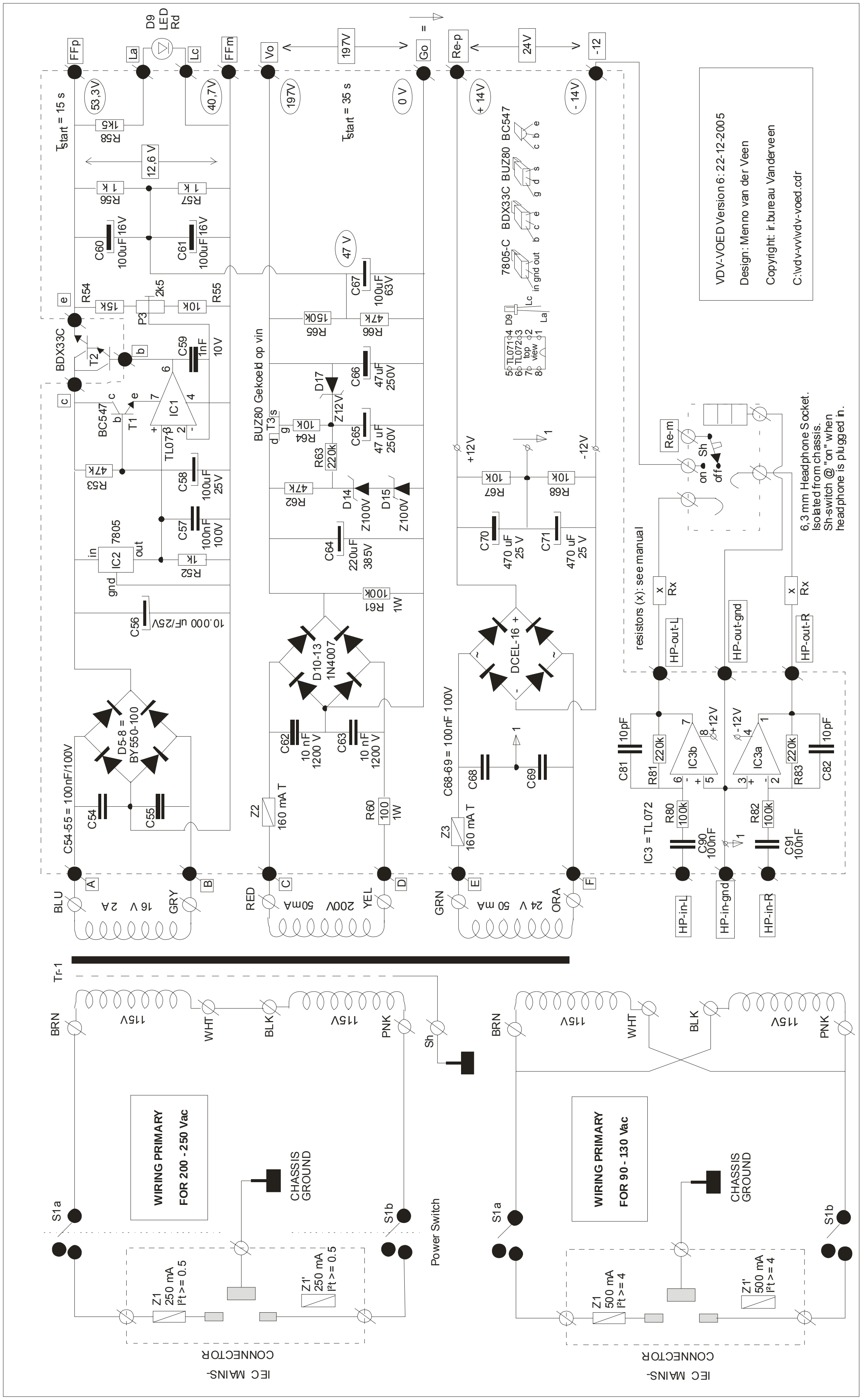

VDV-VOED Version 6: 22-12-2005
Design: Menno van der Veen
Copyright: ir.bureau Vanderveen
C:\vdv-vv\vdv-voed.cdr
WIRING PRIMARY FOR 200 - 250 Vac
WIRING PRIMARY FOR 90 - 130 Vac
CHASSIS GROUND
IEC MAINS-CONNECTOR
Power Switch
Z1 250 mA I²t >= 0.5
Z1' 250 mA I²t >= 0.5
Z1 500 mA I²t = 4
Z1' 500 mA I²t = 4
S1a
S1b
Tr-1
BRN
WHT
BLK
PNK
115V
Sh
BLU 16 V 2A GRY
RED 200V 50mA YEL
GRN 24 V 50 mA ORA
C54-55 = 100nF/100V
D5-8 = BY550-100
D10-13 1N4007
DCEL-16
C68-69 = 100nF 100V
C56 10.000 uF/25V
IC2 7805
BDX33C
BC547
TL072
BUZ80 Gekoeld op vin
Tstart = 15 s
Tstart = 35 s
FFp
La
D9 LED Rd
Lc
FFm
Vo
197V
Go
Re-p
24V
-12
53,3V
40,7V
12,6 V
47 V
0 V
+ 14V
- 14V
+12V
-12V
IC3 = TL072
resistors (x): see manual
HP-out-L
HP-out-gnd
HP-out-R
HP-in-L
HP-in-gnd
HP-in-R
Re-m
6,3 mm Headphone Socket.
Isolated from chassis.
Sh-switch @ "on" when headphone is plugged in.
7805-C BDX33C BUZ80 BC547

LIST OF COMPONENTS

Resistors				
CODE	VALUE	TYPE	QUANTITY	MARKING
R11	47kΩ	½ Watt carbon film	2	yellow-violet-orange-gold
R12	470Ω	½ Watt carbon film	2	yellow-violet-brown-gold
R13	1K2Ω	½ Watt carbon film	2	brown-red-red-gold
R14	1K2Ω	½ Watt carbon film	2	brown-red-red-gold
R15	1MΩ	½ Watt carbon film	2	brown-black-green-gold
R16	180KΩ	½ Watt carbon film	2	brown-grey-yellow-gold
R17	0Ω		2	refer to text
R18	27KΩ	½ Watt carbon film	2	red-violet-orange-gold
R19	1K2Ω	½ Watt carbon film	2	brown-red-red-gold
R20	1K2Ω	½ Watt carbon film	2	brown-red-red-gold
R21	220KΩ	½ Watt carbon film	2	red-red-yellow-gold
R22	1KΩ	½ Watt carbon film	2	brown-black-red-gold
R23	1KΩ	½ Watt carbon film	2	brown-black-red-gold
R31	560KΩ	½ Watt carbon film	2	green-blue-orange-gold
R32	2K2Ω	½ Watt carbon film	2	red-red-red-gold
R33	470Ω	½ Watt carbon film	2	yellow-violet-brown-gold
R34	470Ω	½ Watt carbon film	2	yellow-violet-brown-gold
R35	220KΩ	½ Watt carbon film	2	red-red-yellow-gold
R36	100Ω	½ Watt carbon film	2	brown-black-brown-gold
R41	1KΩ	½ Watt carbon film	2	brown-black-red-gold
RvL	100KΩ	½ Watt carbon film	1	brown-black-yellow-gold
RvR	100KΩ	½ Watt carbon film	1	brown-black-yellow-gold
R52	1KΩ	½ Watt carbon film	1	brown-black-red-gold
R53	47KΩ	½ Watt carbon film	1	yellow-violet-orange-gold
R54	15KΩ	½ Watt carbon film	1	brown-green-orange-gold
R55	10KΩ	½ Watt carbon film	1	brown-black-orange-gold
R56	1KΩ	½ Watt carbon film	1	brown-black-red-gold
R57	1KΩ	½ Watt carbon film	1	brown-black-red-gold
R58	1K5Ω	½ Watt carbon film	1	brown-green-red-gold
R60	100Ω	1 Watt metal film	1	brown-black-black-black-brown
R61	100KΩ	1 Watt metal film	1	brown-black-black-orange-brown
R62	47KΩ	½ Watt carbon film	1	gellow-violet-orange-gold
R63	220KΩ	½ Watt carbon film	1	red-red-yellow-gold
R64	10KΩ	½ Watt carbon film	1	brown-black-orange-gold
R65	150KΩ	½ Watt carbon film	1	brown-green-yellow-gold
R66	47KΩ	½ Watt carbon film	1	yellow-violet-orange-gold
R67	10KΩ	½ Watt carbon film	1	brown-black-orange-gold
R68	10KΩ	½ Watt carbon film	1	brown-black-orange-gold
R80	100KΩ	½ Watt carbon film	1	brown-black-yellow-gold
R81	220KΩ	½ Watt carbon film	1	red-red-yellow-gold
R82	100KΩ	½ Watt carbon film	1	brown-black-yellow-gold
R83	220KΩ	½ Watt carbon film	1	red-red-yellow-gold
R-led yellow	10KΩ	½ Watt carbon film	1	brown-black-orange-gold
R-led yellow	3K3Ω	½ Watt carbon film	1	orange-orange-red-gold

Potentiometers				
CODE	VALUE	TYPE	QUANTITY	MARKING
P1	100kΩ log	stereo volume control ALPS	1	100KAX2
P2	100kΩ lin	stereo balance control ALPS	1	100KBX2
P3	2k5Ω	trimpot small horiz	1	2K5

Capacitors

CODE	VALUE	TYPE	QUANTITY	MARKING
C11	220µF / 25V	electrolytic cap radial	2	220u 25V
C12	100nF / 100V	capacitor radial MKT	2	u1 K100
C13	220µF / 25V	electrolytic cap radial	2	220u 25V
C14	100nF / 100V	capacitor radial MKT	2	u1 K100
C15	220nF / 200V	capacitor axial MKT	2	0.22uF 400V
C16	12nF/100V	capacitor radial MKT	2	12n 400
C17	3,9nF	capacitor radial MKT	2	3n9 400
C18	220pF/160V	capacitor axial polystyrene	2	220
C19	220µF / 25V	electrolytic cap radial	2	220u 25V
C20	100nF / 100V	capacitor radial MKT	2	u1 K100
C21	1µF / 200V	capacitor axial MKT	2	1uF 400V
C22	47µF / 250V	electrolytic cap radial	2	47u 400V
C23	100nF/200V	capacitor radial MKP	2	u1 K250
C24	47µF / 250V	electrolytic cap radial	2	47u 400V
C25	100nF/200V	capacitor radial MKP	2	u1 K250
C31	220µF / 25V	electrolytic cap radial	2	220u 25V
C32	100nF / 100V	capacitor radial MKT	2	u1 K100
C33	220µF / 25V	electrolytic cap radial	2	220u 25V
C34	100nF / 100V	capacitor radial MKT	2	u1 K100
C35	1µF / 200V	capacitor axial MKT	2	1uF 400V
C36	47µF / 250V	electrolytic cap radial	2	47u 400V
C37	100nF/200V	capacitor radial MKP	2	u1 K250
C54	100nF / 100V	capacitor radial MKT	1	u1 K100
C55	100nF / 100V	capacitor radial MKT	1	u1 K100
C56	10.000µF/25V	electrolytic cap radial	1	10000uF 25V
C57	100nF / 100V	capacitor radial MKT	1	u1 K100
C58	100µF/25V	electrolytic cap radial	1	100u 25V
C59	1nF/10V	capacitor radial MKT	1	1n 400
C60	100µF/25V	electrolytic cap radial	1	100u 25V
C61	100µF/25V	electrolytic cap radial	1	100u 25V
C62	10nF/1200V	capacitor radial MKP	1	10n 1K2
C63	10nF/1200V	capacitor radial MKP	1	10n 1K2
C64	220µF/385V	electrolytic cap radial	1	220uF 400V
C65	47µF / 250V	electrolytic cap radial	1	47u 400V
C66	47µF / 250V	electrolytic cap radial	1	47u 400V
C67	100µF/63V	electrolytic cap radial	1	100u 63V
C68	100nF / 100V	capacitor radial MKT	1	u1 K100
C69	100nF / 100V	capacitor radial MKT	1	u1 K100
C70	470µF/25V	electrolytic cap radial	1	470u 25V
C71	470µF/25V	electrolytic cap radial	1	470u 25V
C81	10pF	capacitor radial ceramic	1	100J
C82	10pF	capacitor radial ceramic	1	100J
C90	100nF/50V	capacitor radial polyester	1	0.1 63
C91	100nF/50V	capacitor radial polyester	1	0.1 63

Valves

B2	ECC82/12AU7	double triode Electro Harmonix	2	
B4	ECC82/12AU7	double triode Electro Harmonix	2	
B3	ECC81/12AT7	double triode Electro Harmonix	2	

Semiconductors

CODE	DESCRIPTION	TYPE	QUANTITY	PRINTING
D1	diode	1N4148	1	1N4148
D5 - 8	diode	BY550-100	4	BY550
D9	led	red	1	
D10 - 13	diode	1N4007	4	1N4007
D14	Zener diode	100V	1	100
D15	Zener diode	100V	1	100
DCEL16	bridge rectifier		1	AM154
D17	Zener diode	12V	1	12
D	LED	yellow see text	1	
D	Zener diode	150V see text	1	150
T1	transistor	BC547B	1	C547B
T2	transistor	BDX33C darlington	1	BDX33C
T3	transistor	BUZ80A mosfet	1	04N80C3
IC1	IC	TL071 op-amp	1	TL071
IC2	IC	7805 Voltage regulator	1	L78M05

IC3	IC	TL072 op-amp	1	TL072

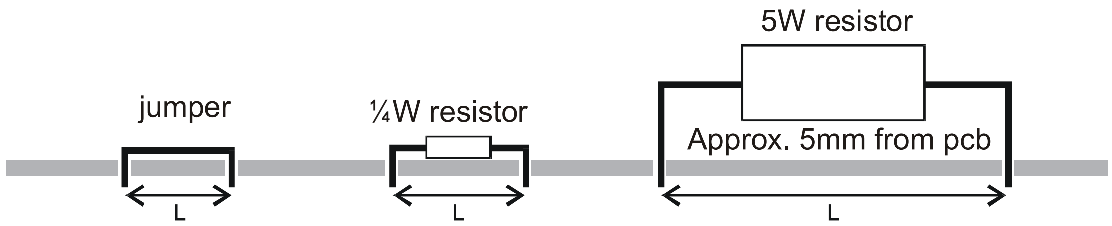
Other items

Cabinet	lower part	zincor black	1	
Cabinet	upper part	zincor black	1	
Front	Front panel	plastic grey	1	MCML05
Knob	knob	black aluminium	1	50mm diam.
Knob	knob	black aluminium	2	17mm diam.
S-1 (a+b)	switch	toggle mains	1	
S-2	switch	toggle MM/MC	1	
S-3	switch	5 way selector	1	
Input	headphone	switched	1	
Input	mains	with fuseholder	1	
Input	2x stereo input	cinch gold plated	4	
Tr1	transformer	Amplimo mains	1	2N1424
Tr2	transformer	Vanderveen MC	2	MC10
PCB	set of 5	Vanderveen	1	
Valve socket	noval	pcb mount gold plated	6	
Re	relay	headphone	1	Omron
IC socket	for IC1, IC3	DIL 8	2	
Fuseholder	for Z2, Z3	TR5 pcb mount	2	
Z1,Z1’	time lag fuse	IEC127 5x20mm glass	2	T0,25A I^2t min.0,5
Z2, Z3	time lag fuse	TR5 plug in	5	T0,16A
Shaft	for S-3	217mm extension shaft	1	
Shaft support		shaft support 6mm	1	
Shaft coupling		for extension shaft	2	
Bush	nylon 7,5mm	spacer for selector knob	1	
Grommet	wire conduct	cabinet partition	4	
Heatsink	for T3	metal black	1	
Isolationset	for T2 en T3	complete	2	
Solder terminal		ceramic lug pcb mount	71	
Solder terminal	tag	M3 / 3 way	1	
Foot			3	
Mains cord		complete	1	

Assembly materials

M3x10mm	screw	counter sunk	black	2	for mains input
M3x 5mm	screw	pan head	zinc plated	14	for pcb’s
M3x12mm	screw	thumbscrew	zinc plated	1	phono ground
M4x 8mm	screw	pan head	zinc plated	5	for feet and cover
M4x12mm	screw	pan head	black hex socket	4	for front panel
ST2,9x13mm	screw	pan head	black	4	for cinch inputs
M3 nut	nut		zinc plated	2	for mains input
M3 washer	spring washer			3	for mains input
M3 washer	washer	nylon	white	2	for input pcb
M5x60mm	screw	pan head	zinc plated	1	for mains transformer
M5	nut		zinc plated	2	for mains transformer
M5	washer		zinc plated	2	for mains transformer
Metal washer	dished washer	70mm	zinc plated	2	for mains transformer
Rubber washer	washer	70mm	neoprene	2	for mains transformer
Solder	solder	with silver	SILTECH	45	grams
Wire	wire		several colors	1	set
Wire	silver wire	0.5mm diam	SILTECH	3	meter
Heat shrink			3 diameters	1	set
Cable ties	Cable ties	80 mm	black	20	pcs

CONSTRUCTION - general hints -



MOUNTING COMPONENTS ON THE PCB
Some examples for the mounting of axial components (= longitudinal leads) are drawn above. Determine length “L” for these components by measuring the distance between the holes in the circuit board. Then bend the leads to the right size using a pair of pliers. The components will then fit neatly into the holes of the circuit board. To prevent the part from falling out when turning the PCB upside down, you can bend the leads slightly outwards.

SOLDERING
A good soldering technique is important for long term reliability and the correct functioning of the set.
Bad solder connections (“dry joints”) are the main cause of poor electrical contact. These can work loose after several cycles of warming up and cooling down.
Note the following:
1. Use a good soldering iron rated at a medium power (30-75 Watt).
2. Only use the high quality solder supplied in the kit. This contains silver and a resin core.
3. Briefly preheat the contact and the lead to be soldered by touching both parts at the same time with the soldering iron.
4. Then introduce the solder, letting it flow properly round the lead.
5. Use of the correct amount of solder is very important (see figure above).
6. Visually check the joint: a good joint is shiny, a bad one is dull.
7. Cut the leads close to the soldered joint to ensure that there are no long protruding leads. Corona discharge from sharp points at high voltage can be prevented in this way.
8. Experts recommend against cutting the leads after soldering as this might deform the joint causing bad contacts after a period of time. However cutting before soldering is not always possible, therefore trim the lead back after soldering, and to guarantee good connections you can reheat each joint with the soldering iron.

RESISTORS – colour code-index

The value and tolerance of resistors are coded by coloured bands (three or four for value and one for tolerance). It is very important that you study the indexes printed below and pick and place the resistors very carefully. Resistors are not polarized; you don't have to pay extra attention to correct positioning on the PCB.

The 1 Watt metal film resistors are clearly recognizable by their pale blue colour and they are larger than the ½ Watt carbon film resistors.

COLOUR-CODE-INDEX 1 for ½ Watt resistors (3+1 bands in total)

COLOUR		BAND 1	BAND 2	BAND 3
black	bl	0	0	x 1
brown	br	1	1	x 10
red	rd	2	2	x 100
orange	or	3	3	x 1K
yellow	ye	4	4	x 10K
green	grn	5	5	x 100K
blue	bl	6	6	x 1M
violet	vi	7	7	x 0.1
grey	gry	8	8	x 0.01
white	wt	9	9	

TOLERANCES: brown 1%, red 2%, gold 5%

EXAMPLE: brown - green - yellow - gold = 150kΩ / 5%

COLOUR-CODE-INDEX 2 for 1 Watt resistors (4+1 bands in total)

COLOUR		BAND 1	BAND 2	BAND 3	BAND 4
black	bl	0	0	0	x 1
brown	br	1	1	1	x 10
red	rd	2	2	2	x 100
orange	or	3	3	3	x 1K
yellow	ye	4	4	4	x 10K
green	grn	5	5	5	x 100K
blue	bl	6	6	6	x 1M
violet	vi	7	7	7	x 10M
grey	gry	8	8	8	
white	wt	9	9	9	
gold	gld				x 0.1
silver	sil				x 0.01

TOLERANCES: brown 1%, red 2%, gold 5%

EXAMPLE: yellow – violet – black – red - brown = 47kΩ / 1%

STEP 1 – power supply circuit board - solder terminals

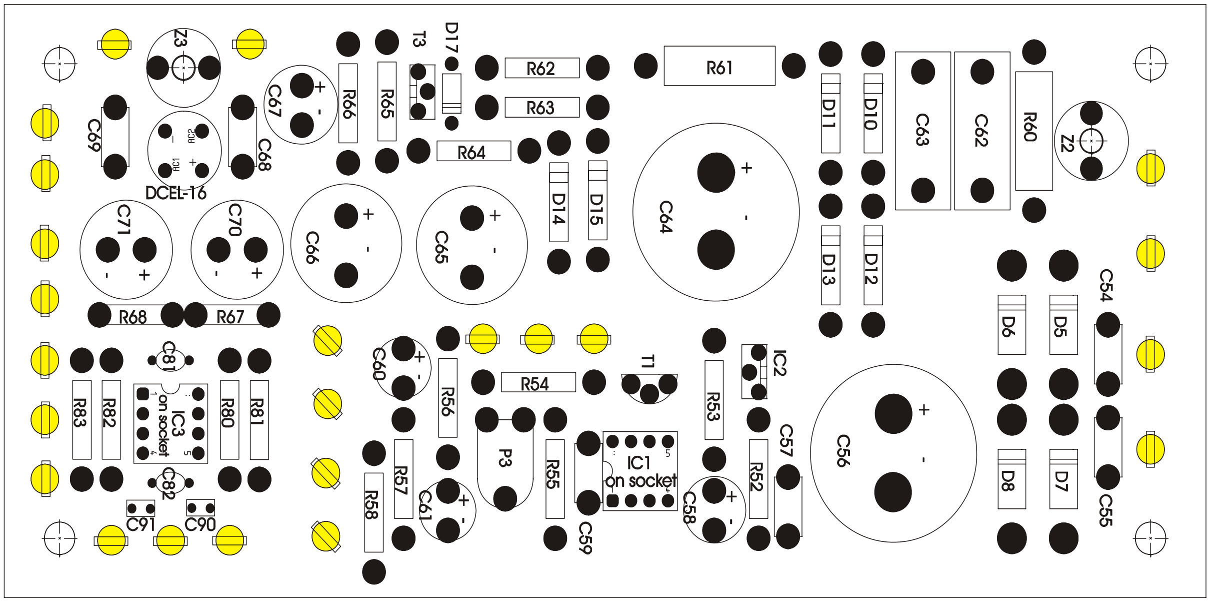


Figure 1

1. One can recognize this circuit board by the text: "VDV-6, COPYRIGHT VANDERVEEN". The side with this printed text is the correct side for mounting the components (**component side**). The other side of the PCB is for the soldered joints (**solder side**). The same applies to the four other circuit boards of this amplifier.
2. First push the 23 small solder terminals into their holes on the component side of the PCB using a pair of pliers and align them as shown in figure 1. Solder them into place (to ensure a nice flat surface first bend the pins aside with a knife before soldering).
3. This mounting method provides a strong connection as well as preventing corona discharge from the PCB to the metal cabinet.

STEP 2 – power supply circuit board – diodes

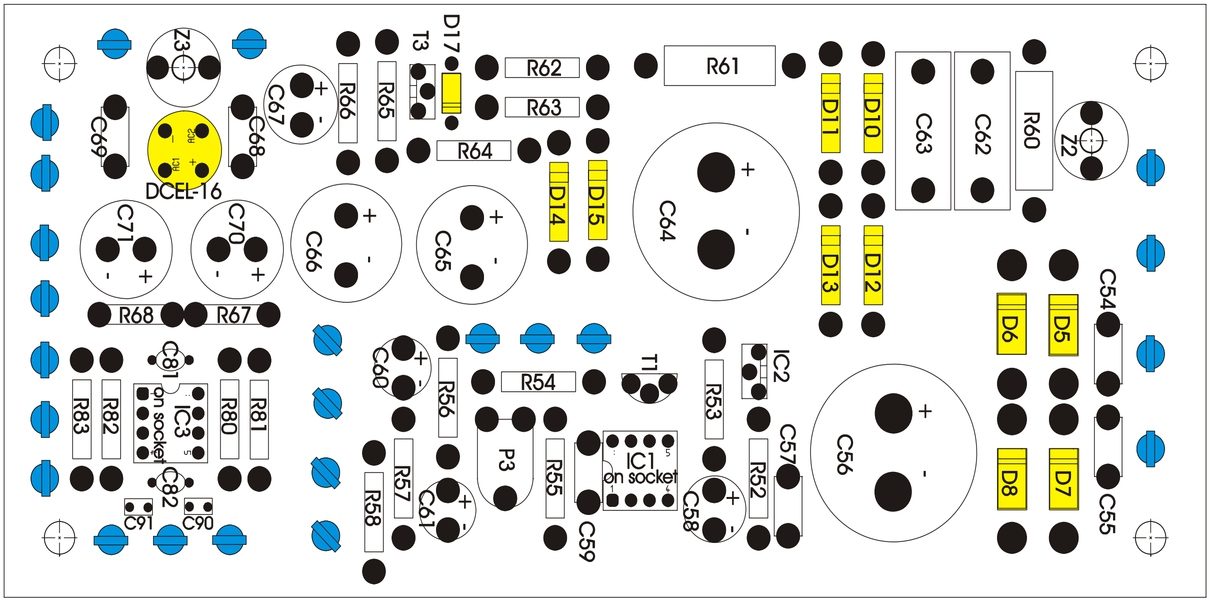


Figure 2

In general: diodes have a fixed polarity; they have a cathode and anode, of which the cathode is always marked. In the figures of this manual you can recognize the cathode by two adjacent lines, the diode itself has a ring marking the cathode, (depending on the type of diode this ring can either be white, grey or black) please take great care to mount the diodes the correct way!

NOTE THAT the components that have already been mounted are coloured turquoise in figure 2, while the parts which are to be mounted at this stage are coloured yellow. From now on this colour code will be used as this makes it easier to recognise what is required for each construction step.

1: Diodes D5-8 are all type BY550 (the larger black ones) and must be mounted 5mm above the circuit board. This allows these diodes to radiate heat more effectively.

2: Diodes D10-13 are type 1N4007 (the smaller black ones) and these can be mounted close to the PCB.

3: Diodes D14 and D15 are Zener-diodes which are used for the 100VDC regulation. Mount these close to the board, (please inspect these carefully; the type number of these diodes contains the number 100).

4: Diode D17 also is a Zener-diode, in this case for 12VDC regulation; again mount this close to the board, (the type number of this diode contains the number 12, please check very carefully, as it looks very much like another diode, type 1N4148 which also comes with this kit !).

5: The part called DCEL-16, is a bridge rectifier, it contains four diodes. This part will fit in four different ways on the PCB, please observe the “+” marking on the housing and mount it the correct way.

6. Solder all in place and crop the leads.

STEP 3 - power supply circuit board – resistors

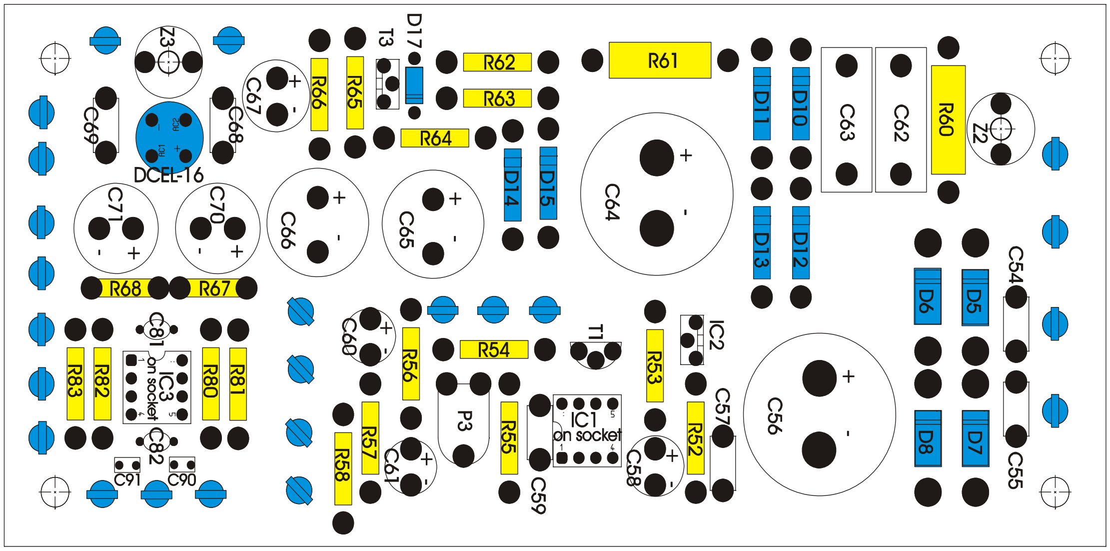


Figure 3

Mount and solder these resistors close to the board.

The holes in the PCB are plated-through, if it is more convenient you can solder the leads on the top side (=component side).

R52	1k = 1000 ohm	brown black red	+tolerance band
R53	47k = 47000 ohm	yellow violet orange	+tolerance band
R54	15k = 15000 ohm	brown green orange	+tolerance band
R55	10k = 10000 ohm	brown black orange	+tolerance band
R56	1k = 1000 ohm	brown black red	+tolerance band
R57	1k = 1000 ohm	brown black red	+tolerance band
R58	1k5 = 1500 ohm	brown green red	+tolerance band
R60 **(1 W)**	100 ohm	brown black black black	+tolerance band
R61 **(1 W)**	100k = 100000 ohm	brown black black orange	+tolerance band
R62	47k = 47000 ohm	yellow violet orange	+tolerance band
R63	220k = 220000 ohm	red red yellow	+tolerance band
R64	10k = 10000 ohm	brown black orange	+tolerance band
R65	150k = 150000 ohm	brown green yellow	+tolerance band
R66	47k = 47000 ohm	yellow violet orange	+tolerance band
R67	10k = 10000 ohm	brown black orange	+tolerance band
R68	10k = 10000 ohm	brown black orange	+tolerance band
R80	100k = 100000 ohm	brown black yellow	+tolerance band
R81	220k = 220000 ohm	red red yellow	+tolerance band
R82	100k = 100000 ohm	brown black yellow	+tolerance band
R83	220k = 220000 ohm	red red yellow	+tolerance band

STEP 4 – power supply circuit board – small capacitors

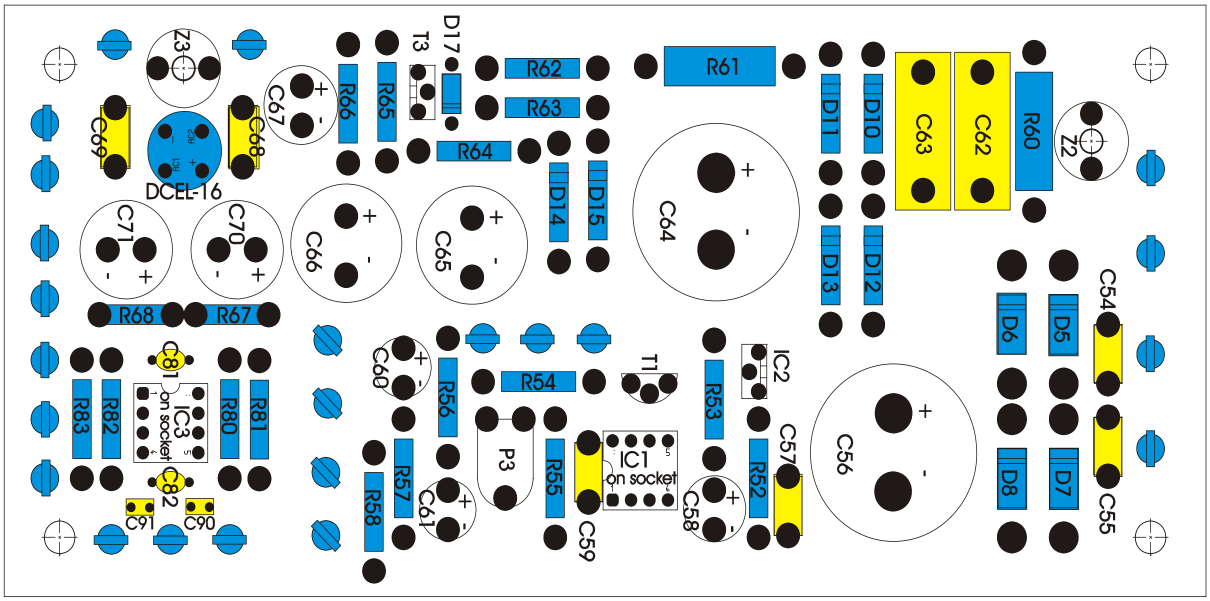


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Figure 4

Mount and solder these small capacitors into place. Like the resistors these don't have a fixed polarity you don't have to pay extra attention to their orientation.

C54	100nF = 0,1µF = µ1	100V
C55	100nF = 0,1µF = µ1	100V
C57	100nF = 0,1µF = µ1	100V
C59	1nF	400V
C62	10nF	1K2 = 1200V
C63	10nF	1K2 = 1200V
C68	100nF = 0,1µF = µ1	100V
C69	100nF = 0,1µF = µ1	100V
C81	10pF	the little blue 100J
C82	10pF	the little blue 100J
C90	100nF = 0,1µF = µ1	63V
C91	100nF = 0,1µF = µ1	63V

STEP 5 - power supply circuit board – transistors and integrated circuits

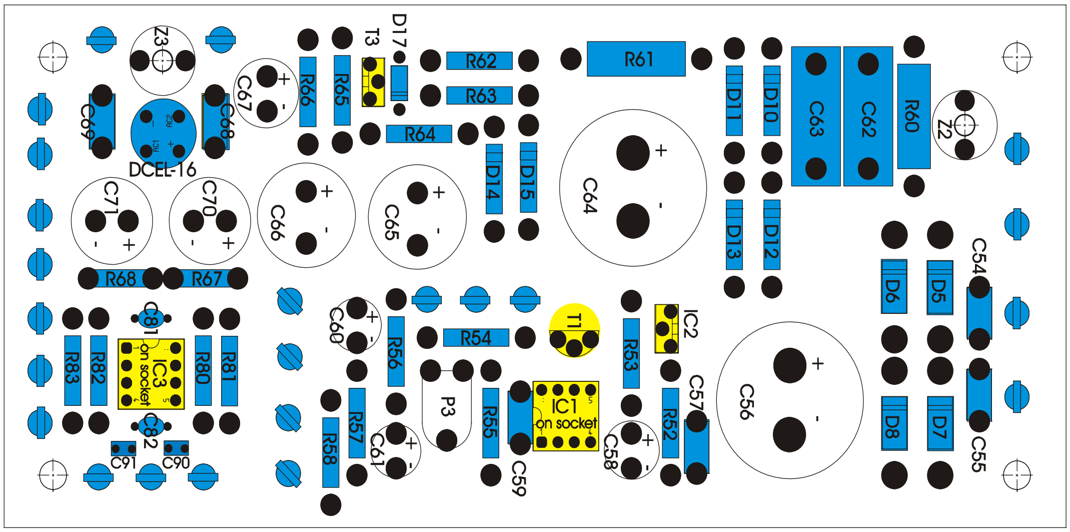


Figure 5

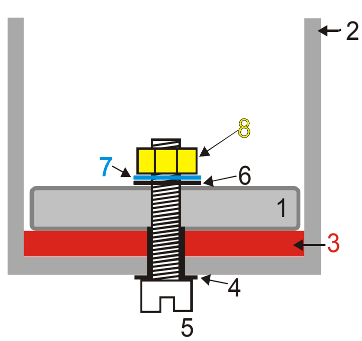
1: Transistor T1 has type number BC547B; solder it into place as indicated in figure 5.

2: IC-1 has type number TL071. This integrated circuit is to be mounted into a socket. This socket has a half round notch at one side as displayed in figure 5, mount and solder it in the correct position and orientation. The correct orientation for part IC-1 is indicated by either a notch or a shiny dot; now carefully push the IC into its socket, its orientation corresponding with the socket.

3: IC-3 has type number TL072 it also comes with a socket. Please proceed as with IC-1.

4: IC2 is a type L78M05, this only has three leads. Mount it upright after bending the middle lead forward a little (text side is at the front)

5: Transistor T3 has type number SPP04N80C3. This transistor generates some heat & has to be mounted with a heat-sink. Prior to soldering it into place on the PCB sufficient insulation materials has to be applied. In your kit you will find a black metal heat-sink, a rectangular slice of silicone rubber (isolating and heat conductive) and a black plastic bush/washer; please study figure 6 carefully. This shows how to mount this transistor with an M3 screw, washer and nut whilst ensuring that the metal back of the transistor remains electrically isolated from the heat-sink. Bend the middle lead of the transistor a little forward and solder into the PCB, taking care that the distance of the heat-sink to the PCB is approx 6mm and the heat-sink is not in contact with the surrounding components.



1: SPP04N80C3
2: Heatsink
3: Isolating sheet
4: Black bush
5: M3x10 screw
6: M3 Washer
7: Spring washer
8: M3 nut

Figure 6

STEP 6 & 7 – power supply circuit board - electrolytic capacitors

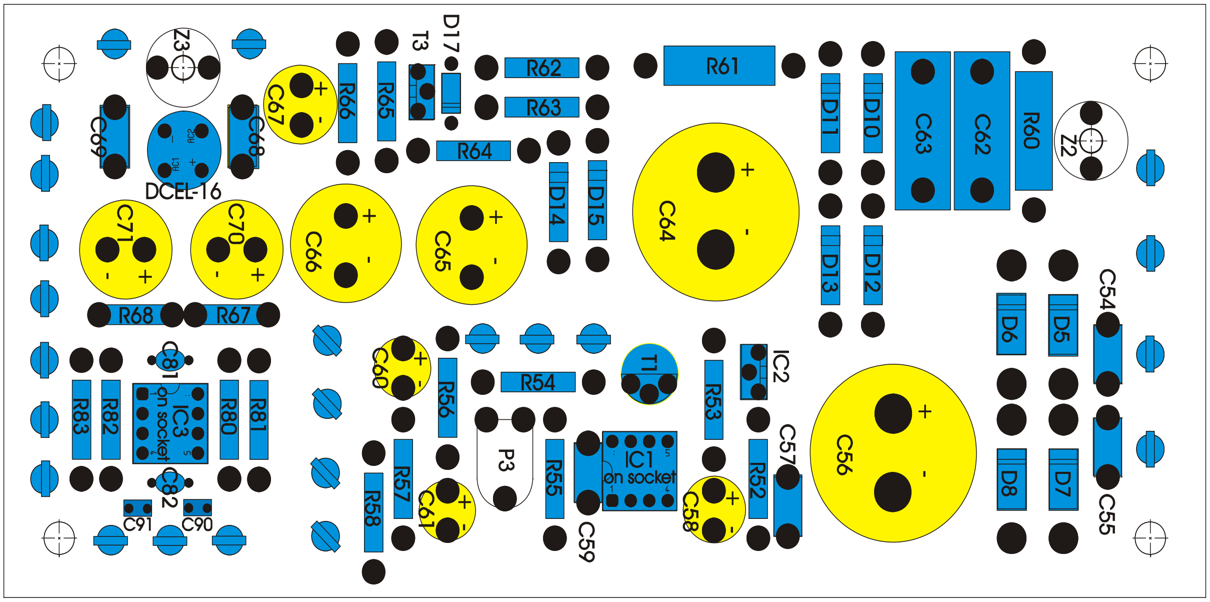


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Figure 7

Electrolytic capacitors have a fixed polarity. All of this type of capacitor supplied with this kit have the negative terminal marked with either a black line on the housing or a **"-"** symbol. Please take great care to mount these capacitors the correct way round. Neglecting to do so will damage the capacitor and also possibly damage the PCB.

Now carefully mount these electrolytic capacitors.

C56	10.000µF	25V
C58	100µF	25V
C60	100µF	25V
C61	100µF	25V
C64	220µF	400V
C65	47µF	400V
C66	47µF	400V
C67	100µF	63V
C70	470µF	25V
C71	470µF	25V

STEP 8 – power supply circuit board – fuses and trimpots

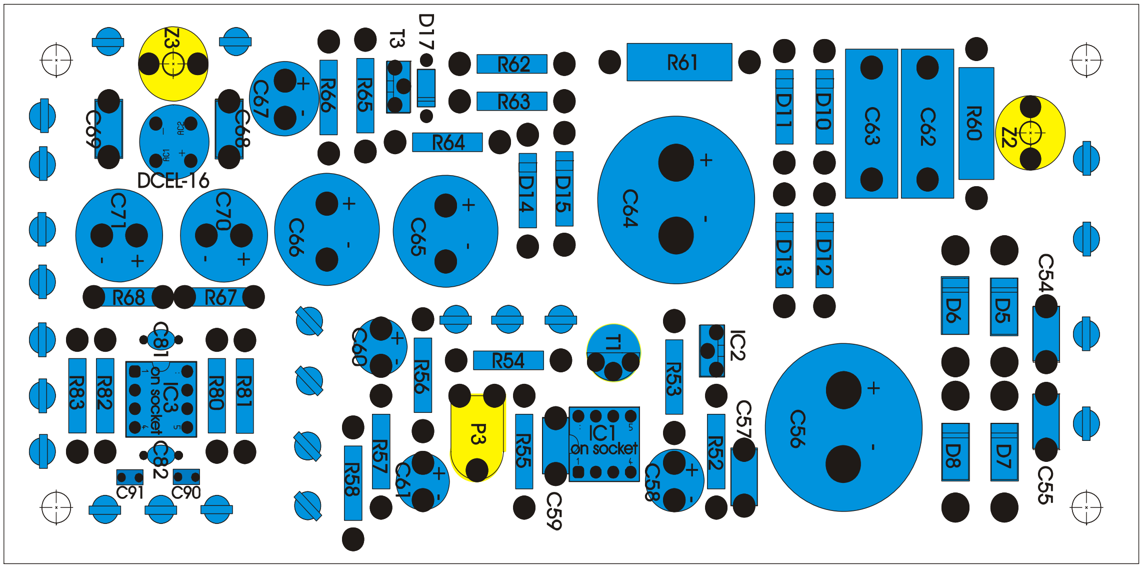

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Figure 8

A type of fuse used with this PCB might be unfamiliar to you. This type of fuse has a round plastic housing and two short leads, and in this application has to be mounted into a socket. Both Z2 and Z3 have the same value (T160mA) which is printed on the top. Because these fuses might be difficult to obtain you will find a few spares supplied with the kit.

First solder both sockets into the printed side, and then insert the fuses Z2 and Z3.

Solder trimpot P3 (2K5 = 2500 Ohm) into the marked position, and turn the indicator (marked by a little arrow) into the mid position using a small screwdriver, (the arrow is to point to the middle of the round section).

Now the power supply circuit board is complete, and should appear as shown in figure 9.

Check that all leads are cut off short, a maximum length of 3mm is allowed for.

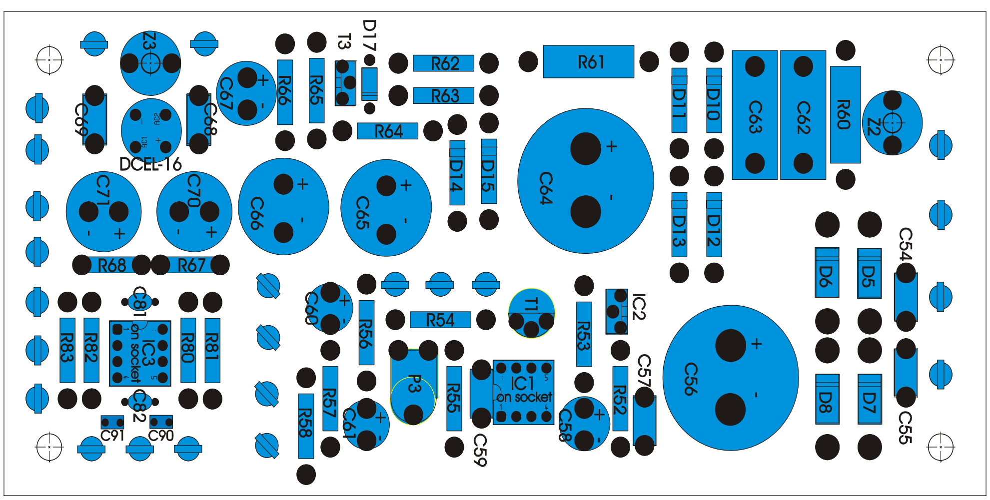

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Figure 9

STEP 9 – input circuit board – solder terminals & wire jumpers

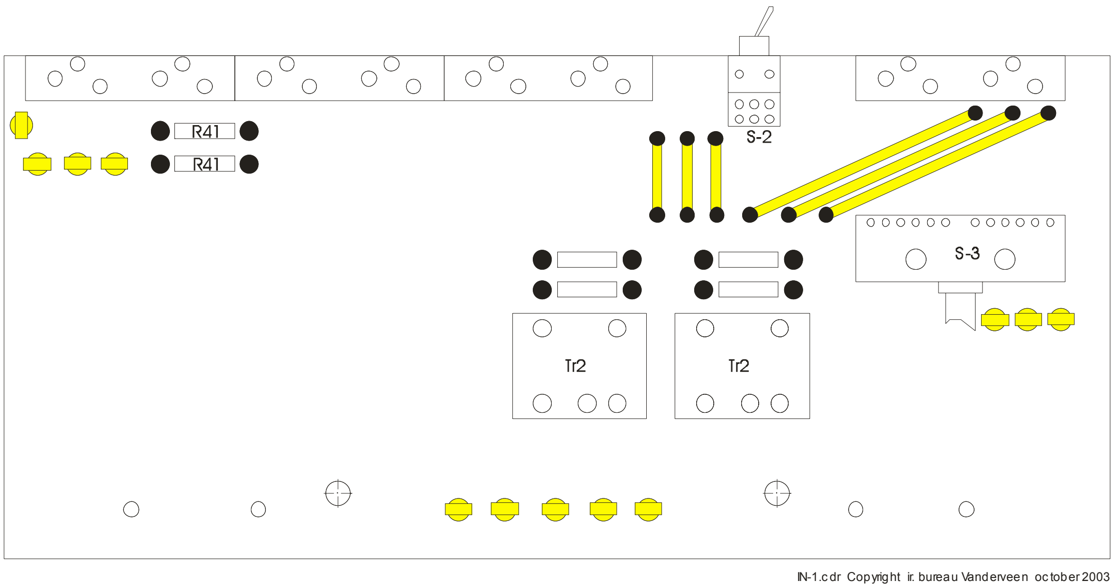

Figure 10

All of the components are to be mounted on the side of the PCB side printed with:
"VDV-VV INPUT-6 ; MC step-up VERSION ; COPYRIGHT 2003 ; VANDERVEEN"

1) Mount twelve solder terminals into the marked positions using the same procedure as with the power supply board.

2) Cut and mount six wire jumpers (displayed in yellow in figure 10) using the thin (solid) brown isolated wire supplied with the kit. Please ensure that the isolation on these wires remains intact to prevent short circuits with the PCB tracks underneath.

STEP 10 – input circuit board – input terminals , MC/MM-switch and input selector

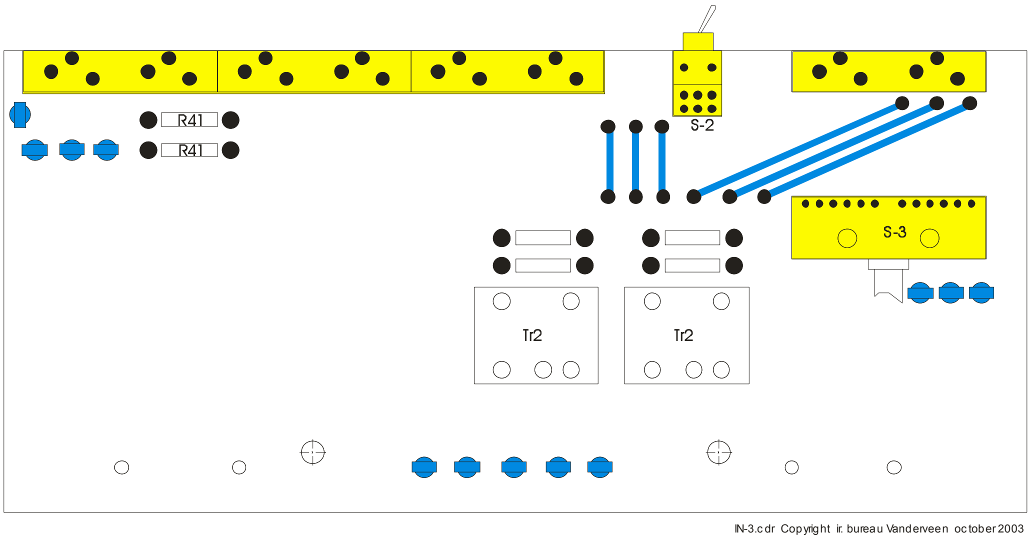

Figure 11

1) Solder the four gold plated input terminals into place on the input PCB. Remove the two little tabs either side of these terminals with a pair of pliers for easier mounting.
2) Insert the MC/MM switch into the PCB, and solder the terminals very carefully. As they are very close together, take care not to short circuit them.
3) Check the input selector switch by rotating it to confirm it has five positions, tighten the central nut if necessary. Next undo the two M3 screws on the input selector switch, insert them into the two holes in the PCB together with the distance washers on top. Now insert the switch terminals into the corresponding holes on the other side of the PCB, and tighten the screws. Please check very carefully that the axis of the switch is exactly square to the long side of the PCB, this is important for a correct fit of the extension shaft. Solder the switch terminals into place. As they are very close together take care not to short-circuit them.

STEP 11 – input circuit board – resistors, capacitors and step-up transformers

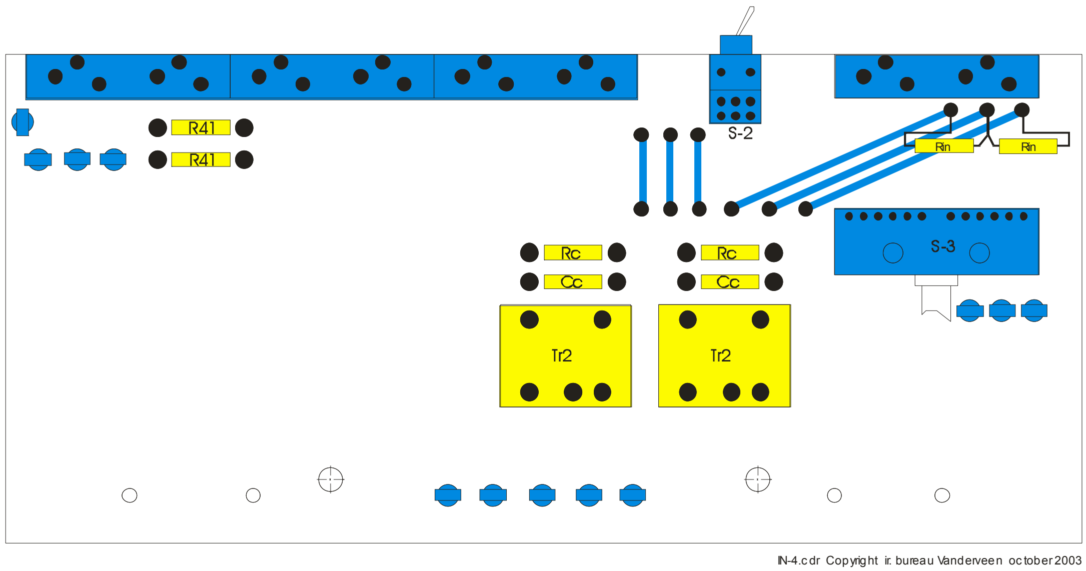

Figure 12

1) Mount the step-up transformers MC-10 and solder into place.
2) Mount resistors R41 into the marked positions (½Watt 1000 ohm, brown black red + tolerance band)
3) If required mount Rc (2 off), Cc (2 off) and Rin (2 off). The necessity of these and their values depend on make and type of your Moving Coil cartridge.

The extensive description of the MC-10 transformer supplied with this construction manual will provide you with all information required to tune these step-up transformers to your MC cartridge. You will find details about resistor **Rin** and high frequency adjustment components **Rc** and **Cc**. In figure 12 these parts are displayed to demonstrate their correct positions. They don't come with the kit because the value of these components is dependent on your MC cartridge.

The input circuit board is now completed (see figure 13)

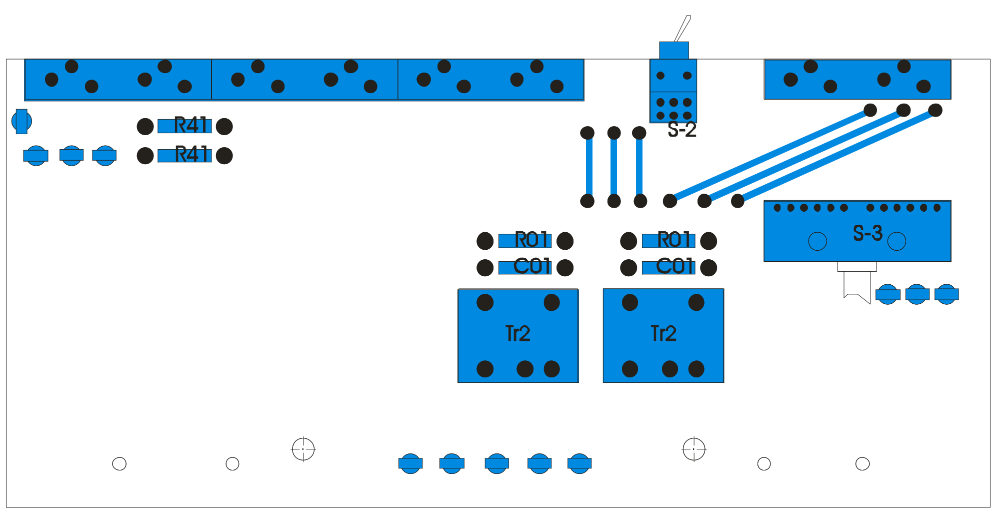

Figure 13

STEP 12 – MD-circuit board –
valve sockets and solder terminals

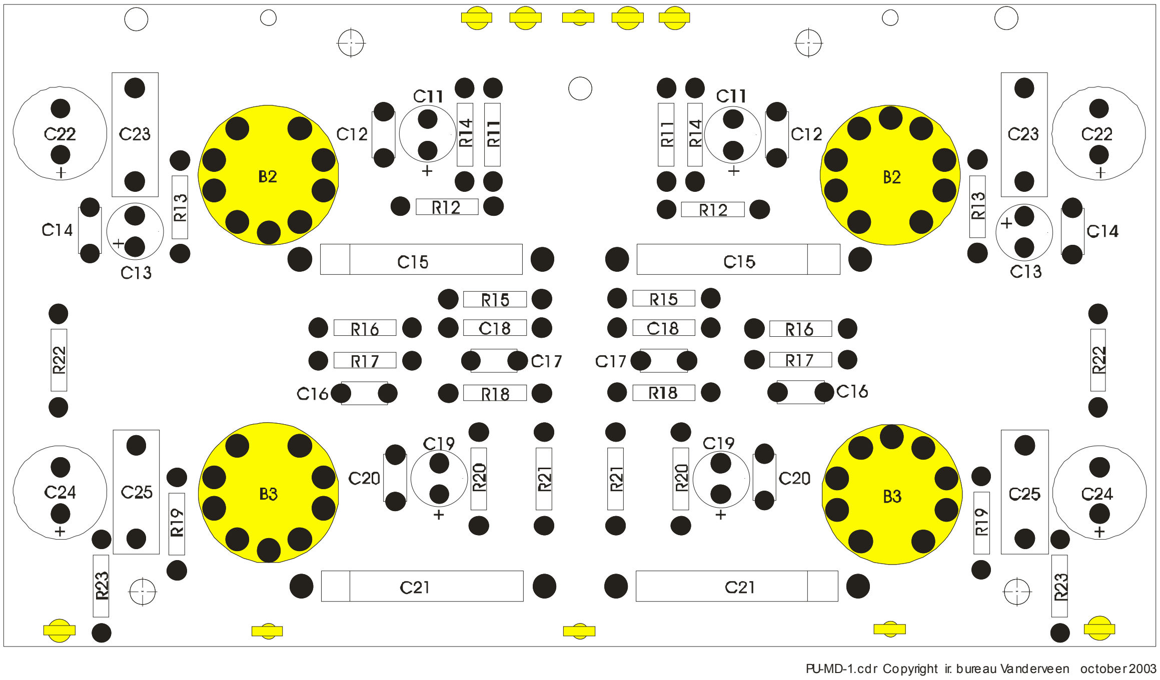

Figure 14

The side showing "VDV-VV: MD-5" is the correct side to mount all of the parts.

1) Mount the little solder terminals into the marked positions as described previously.
2) Solder the Noval valve sockets into place. Note: do not bend the prongs of the Noval sockets over as this is not necessary to keep them in place. If the sockets need replacing at a later date, it will be almost impossible to do so once the prongs have been bent. Bending also puts strain on the contacts.

STEP 13 – MD-circuit board – resistors

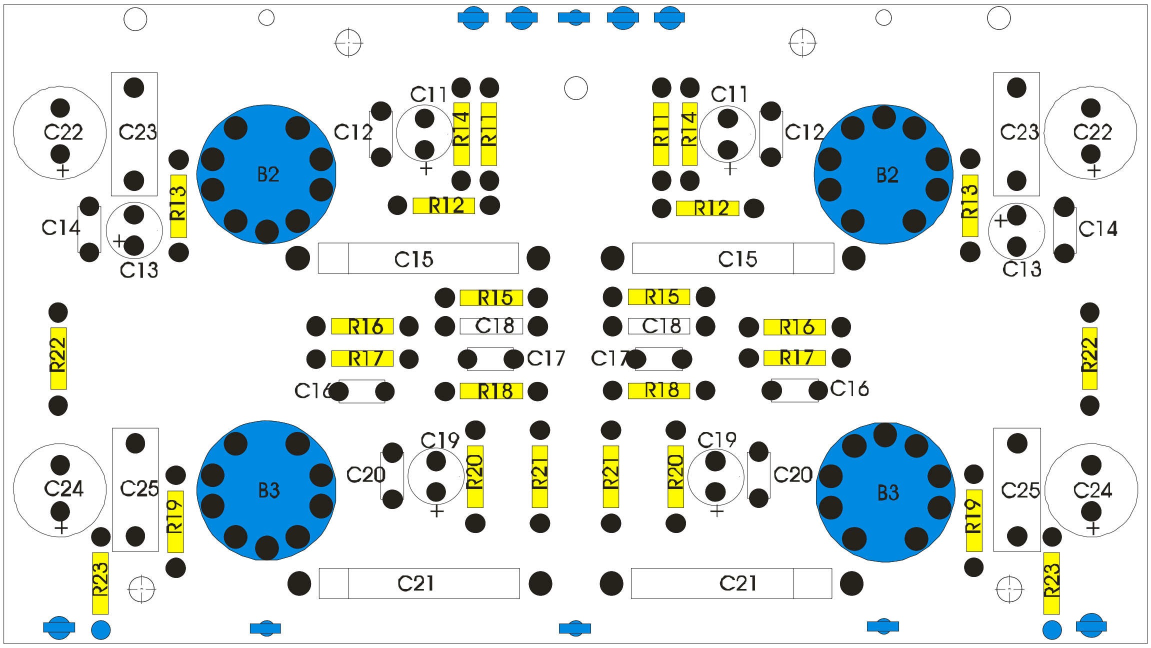

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Figure 15

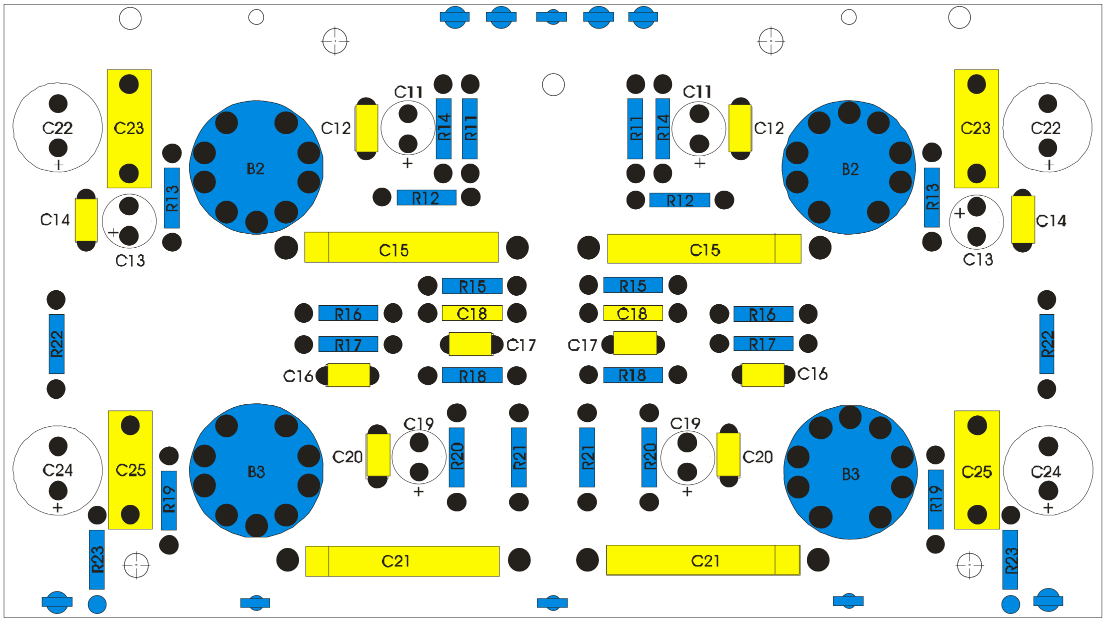
All resistors are ½ Watt types, and are to be mounted on component side.
If it is more convenient you can also solder the resistors this side.

Please note, the values of resistors R16 and R17 are dependent on the type of valve applied in position B2.
If valve B2 is of the 12AU7 / ECC82 type as supplied with the kit, R16 has to be 180k Ohm, ½W and R17 zero Ohm (a wire jumper). Please see step 19 in "experiments" at the end of this manual to find more information about this subject.

Solder these resistors into place:

R11	47k = 47.000 ohm	yellow violet orange	+ tolerance band
R12	470 ohm	yellow violet brown	+ tolerance band
R13	1k2 = 1200 ohm	brown red red	+ tolerance band
R14	1k2 = 1200 ohm	brown red red	+ tolerance band
R15	1M = 1.000.000 ohm	brown black green	+ tolerance band
R16	180k = 180.000 ohm	brown grey yellow	+ tolerance band
R17	0 ohm	wire jumper	
R18	27k = 27.000 ohm	red violet orange	+ tolerance band
R19	1k2 = 1200 ohm	brown red red	+ tolerance band
R20	1k2 = 1200 ohm	brown red red	+ tolerance band
R21	220k = 220.000 ohm	red red yellow	+ tolerance band
R22	1k = 1000 ohm	brown black red	+ tolerance band
R23	1k = 1000 ohm	brown black red	+ tolerance band

STEP 14 – MD-circuit board – capacitors



FU-MD-3.cdr Copyright ir. bureau Vanderveen october 2003

Figure 16

1) Mount the MKH capacitors C12, 14, 16, 17, 20

Pay attention to their values, don't exchange them otherwise the RIAA circuit won't function properly. Don't bend the leads of C16 and C17 as these come off easily.

C12	100nF = 0,1µF = µ1	100V
C14	100nF = 0,1µF = µ1	100V
C16	12nF = 12n	400V
C17	3,9nF = 3n9	400V
C20	100nF = 0,1µF = µ1	100V

2) Mount the little styroflex capacitors C18

C18	220pF	little cyilindrical

3) Solder coupling capacitors C15 and C21 (the yellow cylindrical ones) into the marked positions, pay attention to the correct orientation as indicated by the black line in figure 16)

C15	0,22µF	400V
C21	1µF	400V

4) Mount the supply-decoupling MKP capacitors C23 and C25

C23	100nF = 0,1µF = µ1	250V
C25	100nF = 0,1µF = µ1	250V

STEP 15 – MD-circuit board – electrolytic capacitors

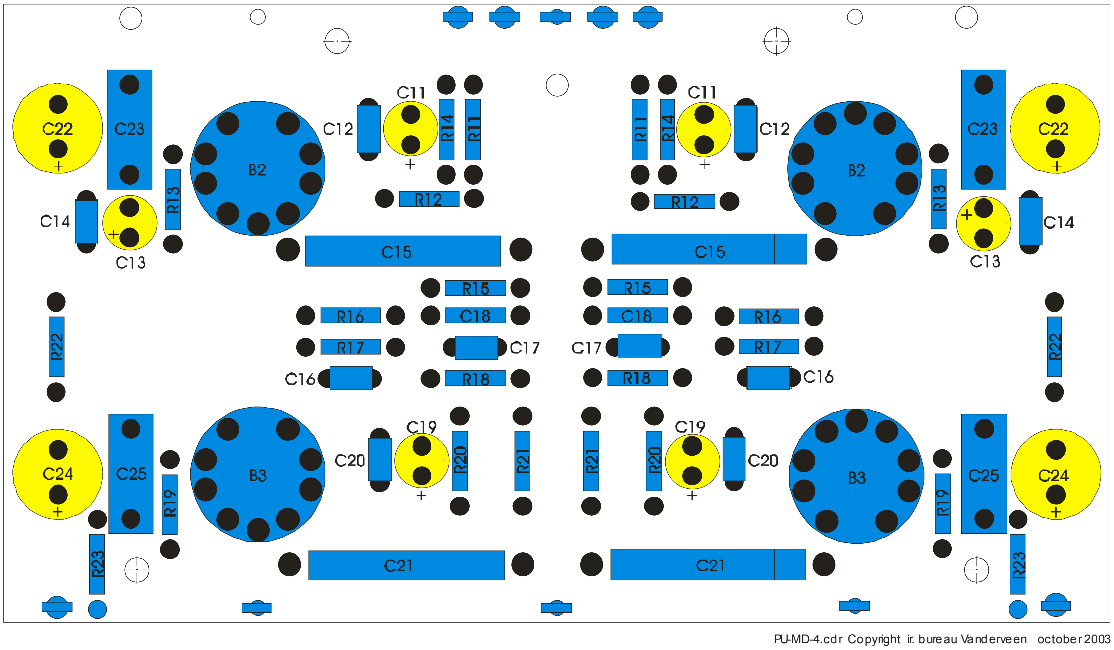


Figure 17

In this step you will mount the electrolytic capacitors, please take care to ensure the correct orientation. In figure 17 the **"+"** terminals are marked however on the housing of the capacitors the **"-"** terminal is marked.

Take extra care when mounting C13 in the right channel, this is the only one in figure 17 which is orientated the other way round.

C11	220µF	25V
C13	220µF	25V
C19	220µF	25V
C22	47µF	400V
C24	47µF	400V

The MD-circuit board is finished now. Please compare your PCB with figure 18 and check that all leads are cut off short.

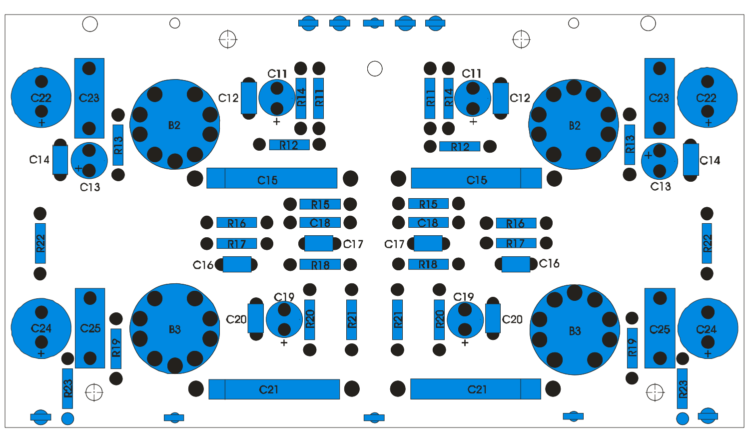


Figure 18

STEP 16 – line circuit board – solder terminals and valve sockets

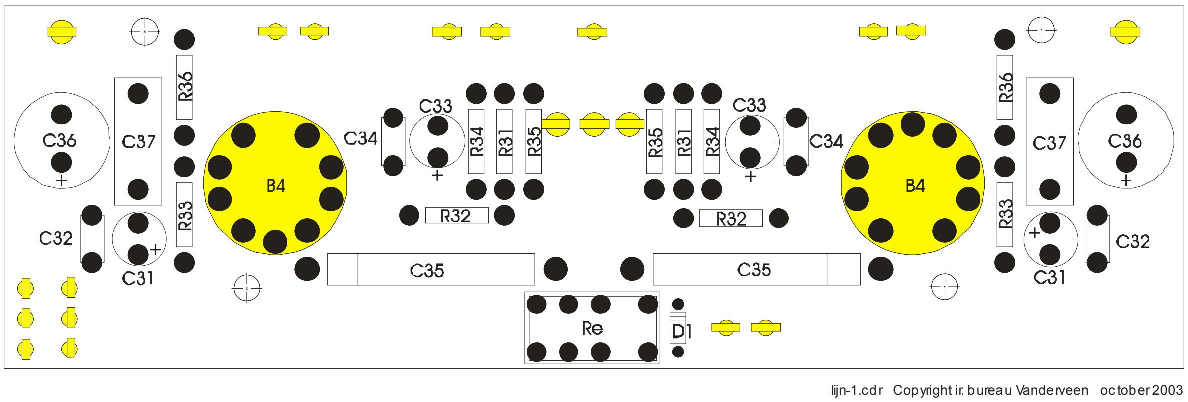


Figure 19

The side showing "Copyright 2003 VDV-LINE 5" is again the correct side to mount all components.

1) Mount and solder all twenty terminals into place as you have done before with the other circuit boards; however take care when bending the pins of the six terminals drawn at the bottom left of figure 19. As these terminals are very close together don't bend the pins completely flat, they are not to touch each other, otherwise a short circuit will be caused.
2) Solder the valve sockets into position.

STEP 17 – line circuit board – resistors

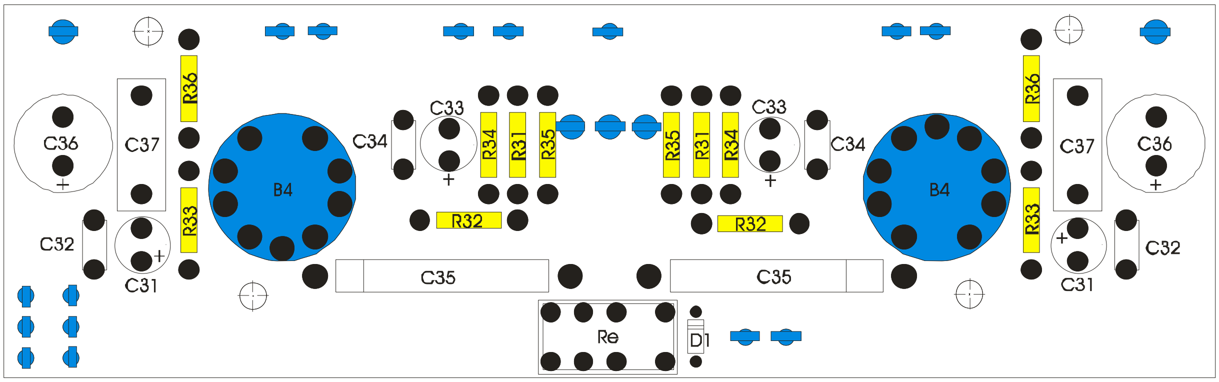


Figure 20

All resistors are ½ Watt type; please study the colour codes below.

Mount the following resistors:

R31	560k = 560.000 ohm	green blue yellow	+ tolerance band
R32	2k2 = 2200 ohm	red red red	+ tolerance band
R33	470 ohm	yellow violet brown	+ tolerance band
R34	470 ohm	yellow violet brown	+ tolerance band
R35	220k = 220.000 ohm	red red yellow	+ tolerance band
R36	100E = 100 ohm	brown black brown	+ tolerance band

STEP 18 – line circuit board – capacitors, relay and diode

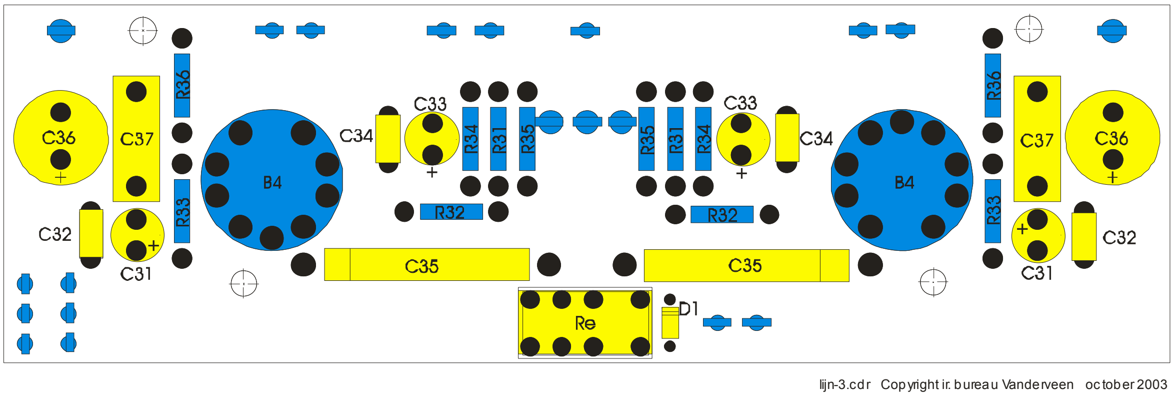


Figure 21

1) Mount relay Re (this relay operates when one connects a headphone) and the small red diode D1 (type 1N4148). Take care to ensure the correct cathode orientation, marked with a black ring on the diode and black lines in figure 21.
2) Insert and solder following MKH / MKP capacitors.

C32	100nF = 0,1µF = µ1	100V
C34	100nF = 0,1µF = µ1	100V
C37	100nF = 0,1µF = µ1	250V

3) Mount coupling capacitors C35 (the yellow cylindrical ones, ensuring the correct orientation indicated by the black line and ring)

C35	1µF	400V

4) Mount the electrolytic capacitors, paying attention to their polarity!

Pay special attention to C31 in the right channel, the **"+"** terminal points the other way round compared to the other capacitors.

C31	220µF	25V
C33	220µF	25V
C36	47µF	400V

Now the line circuit board is complete and finished. Please study figure 22 and check the opposite side for long protruding leads.

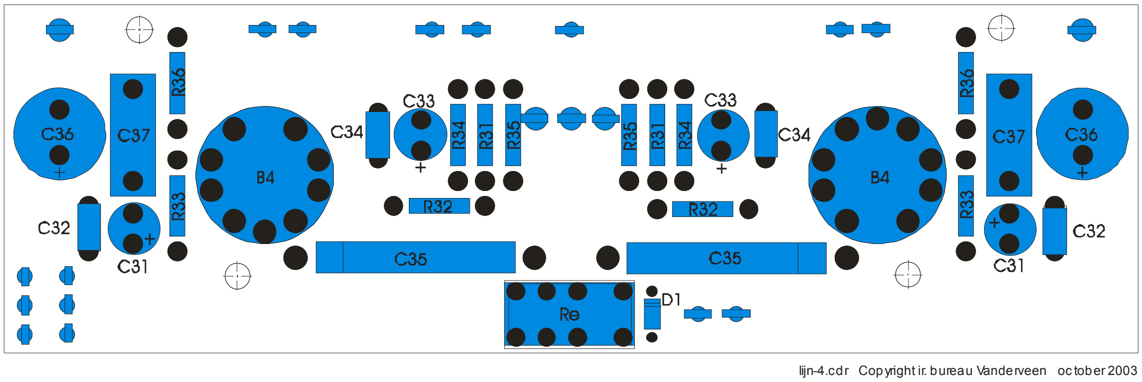


Figure 22

STEP 19
- control circuit board -

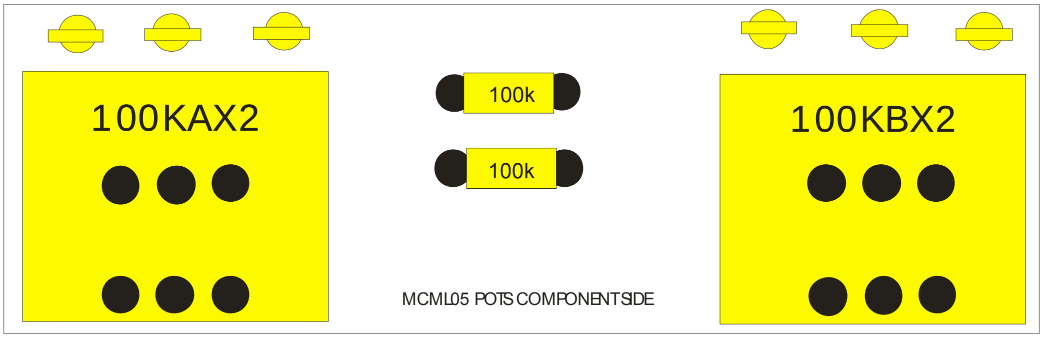


Figure 23

The side displaying "MCML05 POTS COMPONENT SIDE" is the correct side to mount the volume and balance control and the other small items.

1) First mount, align and solder the terminals.
2) Solder both 100k Ohm / ½ Watt resistors RvL and RvR into place (colour coded brown black yellow + tolerance band)
3) Insert both Alps controls into place taking great care not to exchange them as the type numbers are almost identical. The logarithmic volume control carries type number 100KAX2, whilst the balance control is a linear type with number 100KBX2. Solder carefully on the opposite side.

STEP 20 – final assembly –
chassis, mains input, ground terminals, power transformer, mains switch

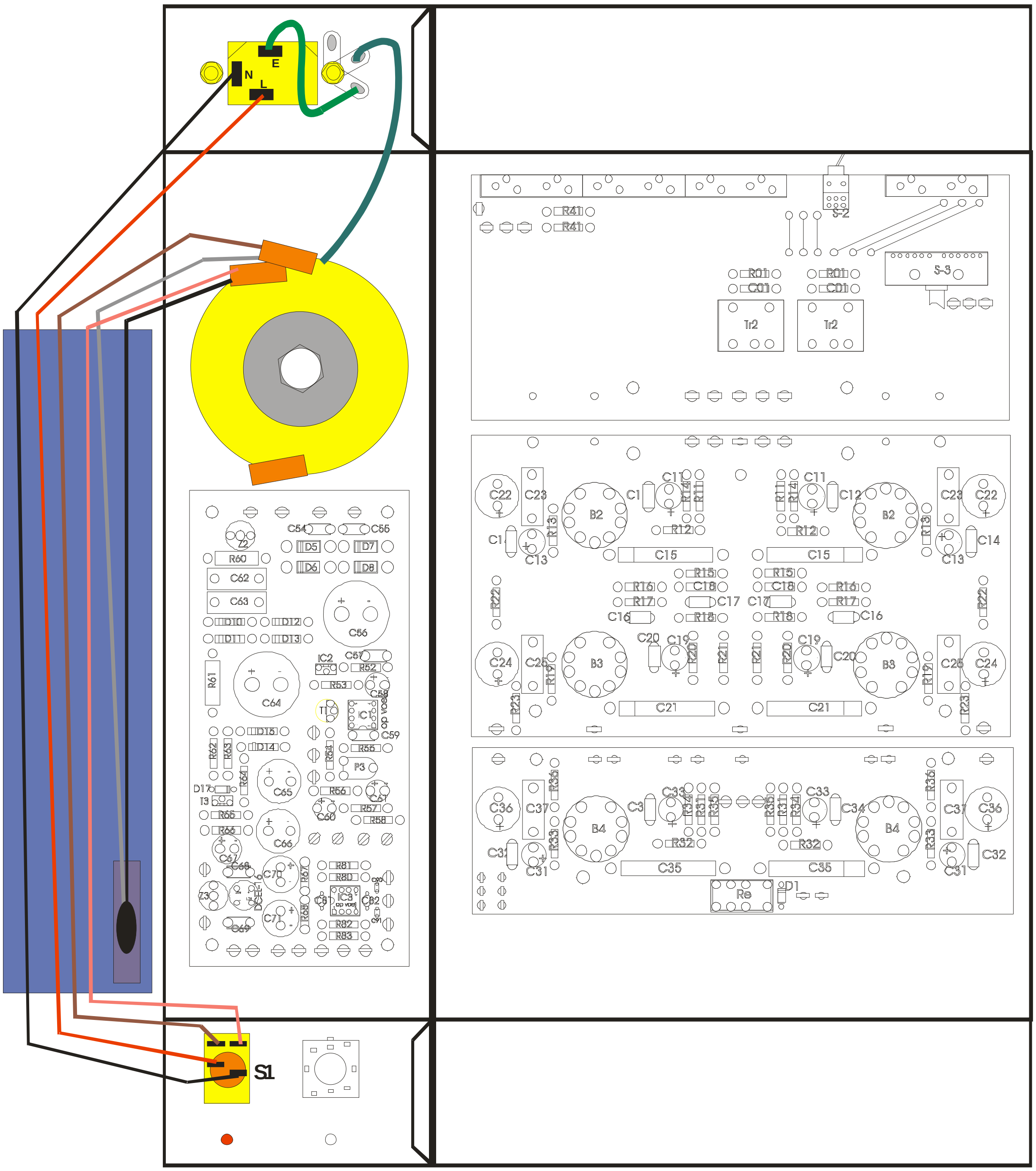


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Figure 24

1) To prevent scratching the cabinet during this assembly step we recommend starting with mounting the three feet using M4x8 screws. (never apply longer screws as these might touch the PCB or transformer)

2) Now whilst there is still good access, mount the four rubber grommets into the holes of the partition between supply and audio sections.

3) Next, mount the mains input terminal to the rear of the cabinet using two black countersunk M3 screw with nuts, spring-washers and the 3-way solder tag under the nut to the right (see figure 24). Push the mains input connector in from outside of the cabinet. Then inert the screw to the right from the outside into its hole followed by a spring washer, followed by the solder tag, then a second spring washer and finally the M3 nut. Firmly tighten this nut and screw as this connection has to be very solid and reliable. This is because it provides the cabinet to earth contact, guaranteeing that the metal cabinet remains connected to mains ground. For electrical safety a 100 % reliable contact is necessary. Be very careful to use the spring washers as they will ensure a firm connection.

4) The upper terminal of the mains input connector **marked "E"** is the earth terminal. Take a 5cm length of the green/yellow striped wire, strip the insulation on both ends back 1cm and insert one stripped end through the little hole in the above mentioned (E) earth-terminal. Bend it so it lies flat against the terminal. Now solder the wire into place to ensure a tension-proof connection.

5) Slip a 2cm length of the 6mm wide heat shrinking sleeve over the wire and shrink it over the solder connection.

6) Next connect this green/yellow wire to the solder tag next to the input. If you bend these terminals a little away from the cabinet, you can easily hook in a wire. Insert the stripped end into the lower hole of the 3-way solder terminal & bend it flat against the terminal before soldering into place. By following these steps you ensure a good safety ground connection with the metal cabinet. It is very important this is very carefully done.

7) Mount two pieces of wire, each 30cm long to terminal L (30cm of red wire) and terminal N (30cm of black wire), using the same techniques used with the E terminal: first hook the lead in, bend flat, solder into place and apply 2cm of the 6mm wide heatshrink to each terminal.

8) Now TEMPORARILY mount the mains switch S1 into its hole in the front of the cabinet. Figure 24 clearly shows the position of the terminals.

9) Next mount the power transformer T1 as follows : insert the M5x60 screw from the bottom into the cabinet and slip over one of the 70mm dished metal washers with its dish facing down and tightly secure with an M5 spring washer and nut, (this dished washer ensures enough space for the mounting screw of the nearest foot). Next slip over one of the 70mm rubber washers, then the transformer itself, another 70mm rubber washer and finally the second 70mm metal washer, an M5 washer and nut. Position the transformer as shown in figure 24 with the black-white & brown-pink leads close to the mains input. (for greater visibility the white lead is displayed grey in figure 24)

10) The two transformer primary windings have to be connected for either 110/115V **or** 230V mains voltage.
If you live in a country with 230V mains voltage wire them in series as follows:
Solder the black wire of the first primary winding to the white wire of the other winding. Insulate this joint very carefully with heatshrink (a 5cm long piece). Now fold back these two connected and isolated wires for approx. 5cm so they will be covered by the length of heatshrink which applied in the next step. (see figure 24)
If you live in a country with 110/115V mains voltage wire in parallel as follows:
Twist the stripped ends of the black and brown transformer leads together, and then twist the stripped ends of the pink and white leads together. Do not solder yet, this will be done in one of the following steps these leads are connected to the mains switch. (Attention: figure 24 shows the 230V wiring option!)

11) Take a 25cm length of the widest heatshrink. Slide it over the transformer primary leads together with the red and black leads of the mains input. Please study figure 24.

12) Now take four 2cm lengths of the 3mm wide heatshrink. Slip these over each of the protruding leads, be sure to slip them far enough over the leads to prevent premature shrinking when soldering the wires to the switch (in stage 13).

13) Solder the four wires to switch S1 as shown in figure 24, the transformer primary wires to terminals A1 and B4 of the power switch, and the wires from the mains inlet to terminals A2 and B5. Before soldering, first hook the wire into the little holes of the terminals and bend them over until they are flat. After the solder joints have cooled down, slide and shrink the pieces of heatshrink over the terminals.

14) Now un-mount switch S1 and place it aside, as this is more convenient for step 21.

15) Solder the green-yellow striped lead (which is internally connected to the electrostatic screen of the power transformer) to the middle terminal of the solder tag next to the mains input (first hook in & then solder). This lead is displayed green in figure 24.

STEP 21 – mounting and wiring of the power supply and transistor T2

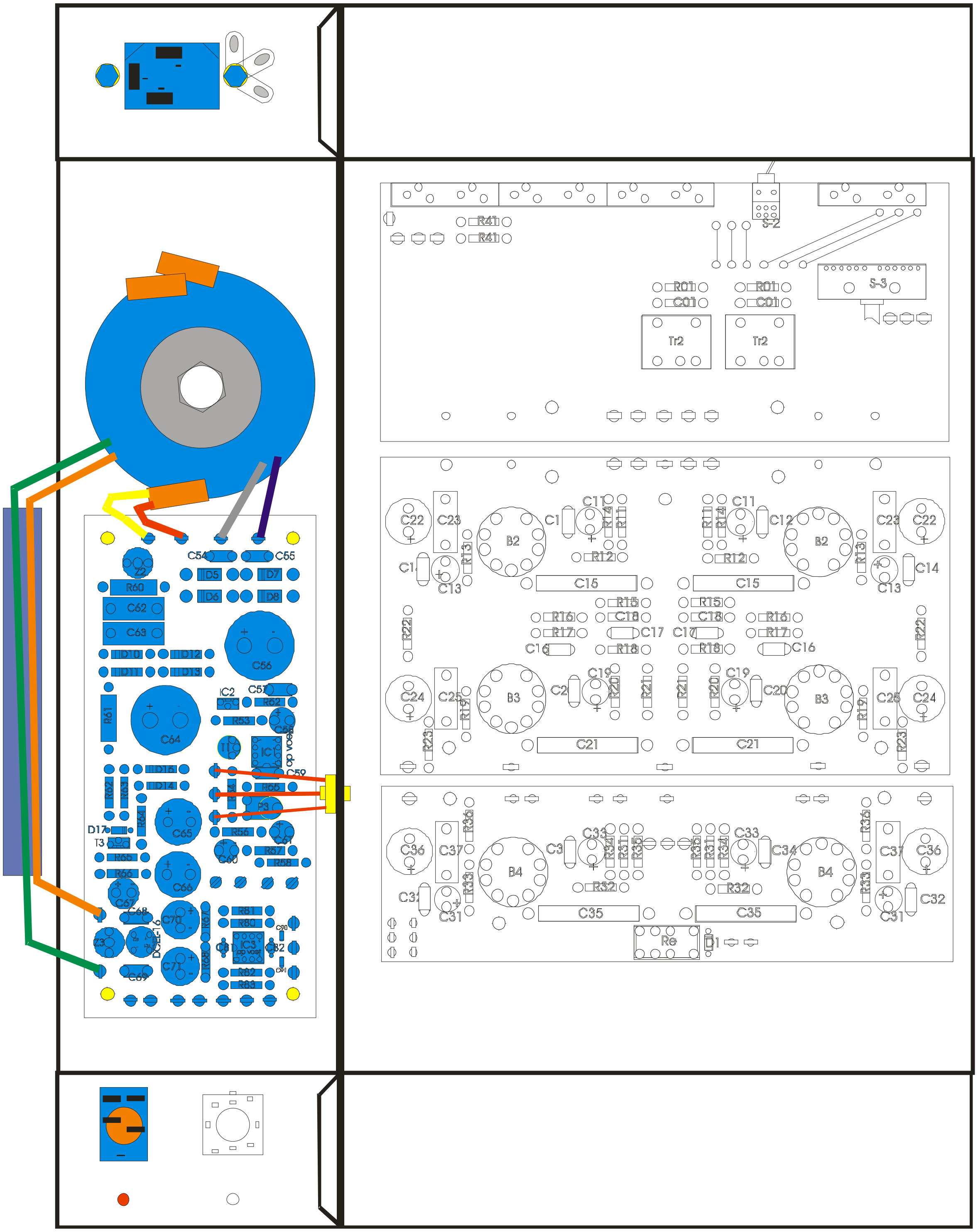

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Figure 25

1) Mount the power supply PCB as shown in figure 25 using four M3x5 screws.

2) Now we are going to mount transistor T2. As this transistor generates some heat, it is placed against the partition which will conduct this heat away.

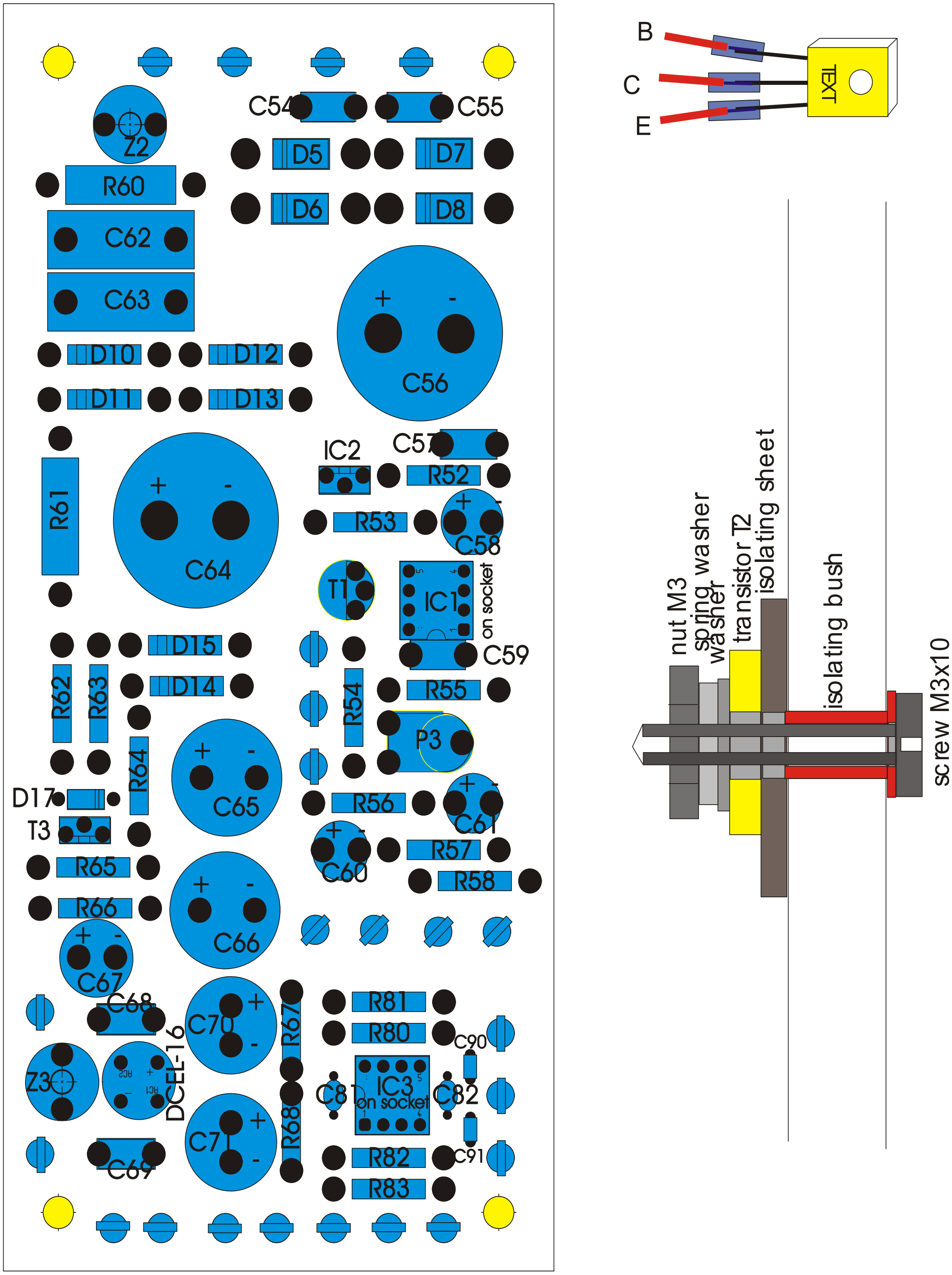

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Figure 26

3) Take transistor T2 (type BDX33C) and lengthen each of the three terminals using 5cm lengths of red wire. Carefully isolate these three solder connections using 2cm lengths of narrow heatshrink. See figure 26.

4) If better heat conduction is required you can sand the partition with fine emery paper at the position where T2 is to be mounted. (see figure 27.)

5) Study figure 26 very carefully and mount transistor T2 accordingly to the partition. This is similar to the mounting of transistor T3 which was carried out in step 5. Apply the rectangular sheet of silicone rubber (which provides isolation and heat conduction) together with a black plastic bush/washer and mount the transistor with an M3 screw, washers and nut in such a manner that the metal back of the transistor is electrically isolated from the partition.

6) The next step is very important; you will need your ohmmeter.

7) Test the conductivity between the earth tag next to the mains input and the middle terminal (collector) of transistor T2. The measured resistance has to be infinite! If your meter shows any resistance, transistor T2 has to be remounted with greater care. This fault could be due to the mounting hole in the partition having a sharp edge, or a misplaced isolation sheet. When your meter no longer indicates any conductivity when T2 is screwed down tightly to the partition this transistor is correctly mounted.

8) Now solder the lengthened leads of T2 to the corresponding solder terminals on the PCB. Please study figures 26 and 27.

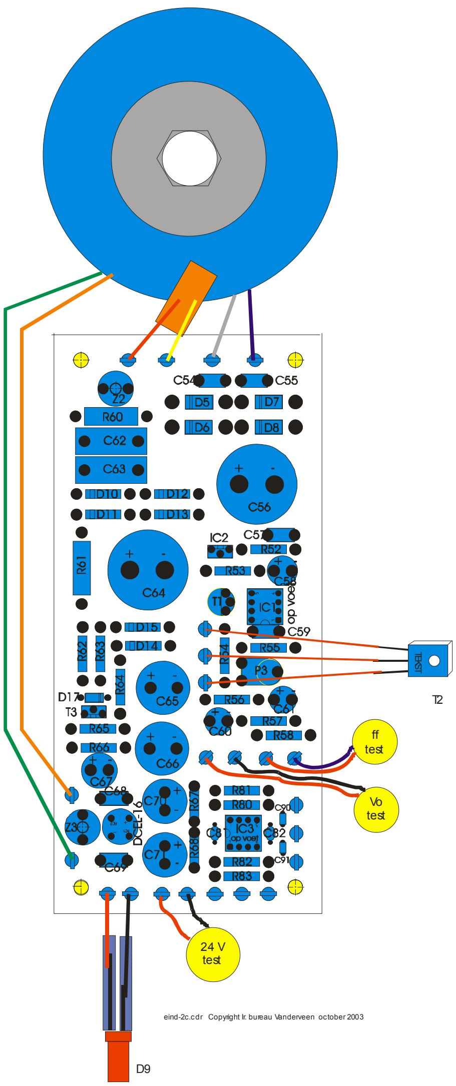

Figure 27

9) Connect the thicker blue and grey transformer leads to their solder terminals on the PCB. Do not shorten these leads, but wind them around a pen to form a coil, these coils will effectively suppress high frequency interference from the mains.

10) Now solder the thinner yellow and red transformer leads to the corresponding solder terminals. If these are too long, also form coils and secure with a cable tie.

11) Slide a 17cm length of thin heatshrink over the remaining green and orange transformer leads. (see figure 25) Now solder these to the terminals on the PCB.

12) Take the red LED from your kit and lengthen its longest termination with an 8cm length of red wire. Lengthen the shorter termination with an 8cm length of black wire. Isolate each solder connection using a 4cm length of thin heatshrink.

13) Solder these two wires to the corresponding PCB terminals, see figure 27.

14) Temporarily remove the small round fuse Z2 from its socket.

15) Mount mains switch S1 firmly to the front of the cabinet. Please ensure that the LED leads are at a distance from the switch terminals.

NOW WE ARE GOING TO TEST THE POWER SUPPLY

1) Insert fuse Z1 (time lag glass fuse 5x20mm 250mA) and the spare fuse Z1’ into the fuseholder of the mains input terminal (both will be accommodated). Connect the supplied mains cord between the amplifier and a mains outlet.

2) Switch on the power switch S1. The red LED must light up!

3) Switch off S1 and wait for three minutes (to discharge the power supply capacitors).

4) Meanwhile study figure 27. This shows some important details for testing.

5) Connect a volt meter (in DC voltage mode) to the “ff“ measuring points. Switch power switch S1 to the on position. After approx. 15 seconds the DC voltage meter should read 12.6V. Please observe that this voltage increases almost linearly with time. The final voltage has to be exactly 12.6V, and is adjusted by using trimpot P3.

6) Switch of S1 and again wait for three minutes.

7) Temporarily remove the mains cord and reinsert the PCB mounted fuse Z2 into its socket.

8) Connect your volt meter to the “Vo” test points. (in DC voltage mode, 200V range) Reconnect the mains supply and switch on. After approx. 30 seconds your meter should show approx. 200V. This voltage is not adjustable.

9) If you measure a substantial higher voltage (like 250V) it is likely that transistor T3 is faulty, or the Zener diodes D14 and D15 are mounted incorrectly.

10) Also check the “24V” test points (meter still in DC-voltage mode), see figure 27. This voltage is neither adjustable nor critical, even 28V is acceptable.

EXPLANATION OF THE POWER SUPPLY
- background information -

During the construction of this amplifier this explanation can be omitted, however it can be of use at a later point to understand how the power supply works. For instance if you want to modify the circuit or if the power supply functions incorrectly.

The circuit diagram shown on page 7 of this manual will guide you.

Mains voltage 230V or 115V at 50 or 60 Hz

This amplifier can be wired for 230V or 115V mains. In the circuit diagram you can ascertain how the primary transformer leads are to be wired in series for 230V or in parallel for 115V. In the case of the parallel wiring option, one has to connect pink to white and black to brown. In this case you have to solder two leads to each of the terminals A1 and B4 of mains switch S1.

The power transformer is designed very liberally, so core saturation will not occur even at 50Hz, 60Hz never being a problem. The core is rather oversized, so even a DC component on the mains won't cause the transformer to hum.

Capture range of the power supply.

The (12.6V) filament supply regulator is designed in such a way that it even functions correctly at a mains voltage as low as 180V (or 90V when configured for 115V operation).

The concept behind this, is that the amplifier should work in Japan with its 100V mains supply as well as in the UK on 240V mains without any limitations such as audible hum caused by a rippled filament supply.

The 200V high voltage is likewise regulated for the same reasons.

The 24V supply is not so critical and for that reason not regulated, the only requirement is that the relay Re operates correctly at 180V mains, which it does.

As previously mentioned the power transformer is very liberally designed. This is necessary for the essentially wide capture range. In addition core saturation caused by DC (the main reason for transformer hum) should not occur.

Conclusion: this power supply meets the high demands required to function correctly on mains voltages between 180 and 240V, resp. 90 and 120V, at 50 as well as 60Hz.

Filament supply slowly increasing in 15 seconds to 12.6V

The secret behind this circuit is transistor T1. Capacitor C58 is slowly charged in 15 seconds through resistor R53. The voltage on the base of transistor T1 increases from 0 to 16V during this interval. Integrated circuit IC1 is responsible for the regulation of the 12.6V supply. Terminal 7 of IC1 is supplied via T1. During power switch-on the emitter voltage of T1 and the output voltage on terminal 6 of IC1 are at 0V, therefore transistor T2 will not conduct the voltage supply to the filaments.

As the voltage increases at the base of T1, the supply voltage of IC1 will equally increase as will the output of IC1 which is connected to the emitter of T2.

This process continues linearly with time until the output voltage divided by the adjustable relationship of resistors R54, P3 and R55, reaches 5.0V. This voltage will then appear at the "-" terminal (2) of IC1. The "+" terminal of IC1 is supplied with 5V regulated by IC2.

At this stage the output voltage on the emitter of T2 has increased sufficiently to enable IC1 to control and regulate the output of this circuit. The circuit is now within its capture range and the output will be stabilized at 12.6V.

Basically in this circuit: the supply to IC1 is supplied by T1 and slowly increases with time. The output voltage of the entire circuit increases proportionally until it is captured by IC1 and kept at constant level (even if the supply voltage of IC1 rises to a higher level)

Filaments at +47VDC level relative to ground.

In the analogue signal part of the pre-amplifier, you will repeatedly find two valves drawn on top of each other, either in SRPP mode or in "identical internal resistance mode" as designed by myself. This means that the cathode of the upper valve-part is at 100VDC level, the cathode of the lower valve-part being at ground level. The filaments are situated very close to these cathodes and should ideally be at a mean voltage level of 50VDC. Due to available resistor values a voltage of 47VDC resulted in this design. Thus the entire filament supply is lifted to a +47VDC level.

This lifting relative to ground is achieved by resistors R65 and 66 & buffered by capacitor C67. Resistors R 56 and 57, together with capacitors C60 and 61 ensure that the +47V level is applied exactly at the midpoint of the 12.6V voltage.

The main task of capacitors C60, 61, 67 is to short circuit the filaments for alternating audio voltages, thus preventing disturbing audio currents from flowing to the cathodes. These capacitors also supply an extra decoupling of the valves, preventing unwanted coupling between valves.

Regulation of the high voltage Vo and the slow 30 seconds increase.

The high voltage supply circuit is very simple. A stable 200V supply is achieved via R62 and two Zener-diodes D14 and D15. Capacitor C65 is charged via R63 in 30 seconds. This increasing voltage reaches the gate of mosfet T3 via R64 (this resistor also prevents oscillation of T3). Located between source and gate of T3 you will see a 12V Zener-diode (D17) to prevent damage to T3 during the switching off the power supply. The output is loaded with C66 effectively suppressing unwanted noise.

High frequency decoupling of the power transformer is well documented in my previous publications. This is achieved by C54, 55 (12,6V circuit) and via R60 plus C62, 63 (high voltage circuit) and C68, 69 (24V circuit).

DC supply for the headphone amplifier and relay Re

The circuit supplying the 24V (2 x 12V) required for the headphone amplifier IC3 is very straight forward. There is no need for regulation here, so why make it more complex than necessary?

WHAT TO DO IF THE POWER SUPPLY DOESN'T FUNCTION CORRECTLY?

A number of check-points are listed below. If you establish a fault condition replace the part or check whether it is correctly mounted.

a) 12,6V supply

First check if there is 5V across resistor R52 (relating to IC2).

Check the slow increase in supply voltage at terminal 7 of IC1 (concerning T1).

Using an ohmmeter check that transistor T2 is correctly isolated (measure between the collector of T2 and the heat sink) (this concerns the correct mounting of T2).

b) high voltage supply Vo

Check the DC voltage across D14 + D15; this should be 200V (this concerns the correct orientation of D14 and D15).

Check whether the voltage across C65 increases from 0 up to 200V in approx. 30 seconds. If not, suspect C65, or you may have picked the wrong value for R63 (220k ohm, red-red-yellow-brown)

Measure the output voltage Vo, if this is considerably higher than 200V, T3 is probably defective and needs to be replaced. (This condition can be caused by a short circuit somewhere else in the amplifier). Check for a short between Vo and ground using an ohmmeter.

c) 24V supply

Not much can go wrong here; the supplied voltage may be as high as 30V. (depending on the mains voltage)

Check fuse Z3 if nothing is working.

Headphone amplifier IC3

This circuit will be described in one of the next construction steps.

STEP 22 – final assembly – mounting the audio PCB's

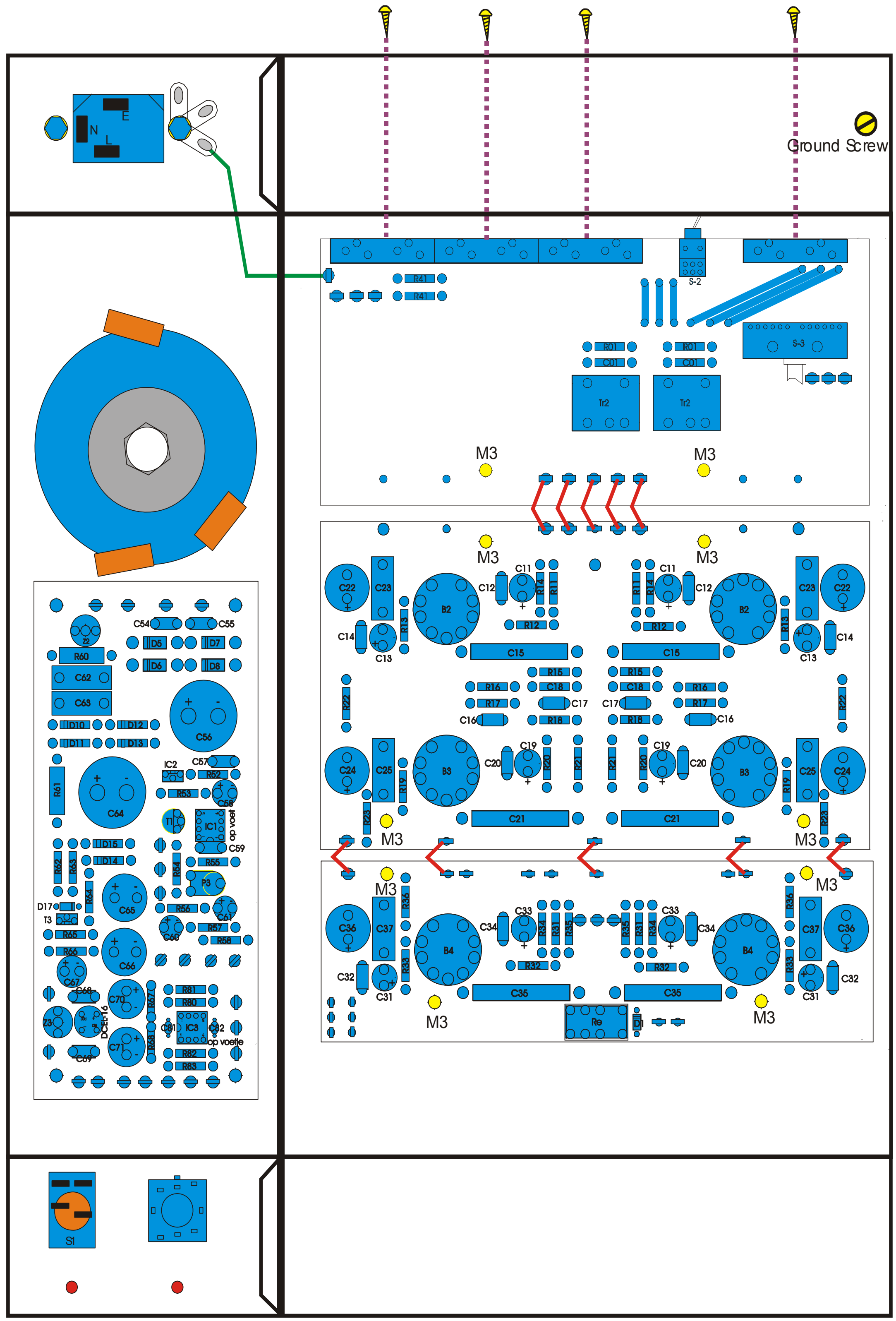

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Figure 28

Mounting the input PCB:

1-a) Check the PCB for long protruding leads - trim if necessary.

1-b) This PCB is mounted with two different types of screw: four self tapping screws into the cinch input terminals through the back of the chassis, and two M3x5 screws onto the supports inside the chassis.

1-c) First fix the input terminals with the four black self tapping screws from outside the chassis.

1-d) Place two nylon washers between the PCB and the M3 supports mounted at the base of the chassis. This will lift the PCB by 1.5mm so the input selector and its extension shaft will fit well. These washers are in your parts kit. Now fix the PCB with two M3x5 screws, taking care not to over tighten these.

Mounting the line- and MD circuit boards.

2-a) First check for any excessively long leads protruding from the board

2-b) Now fix in place with M3x5 screws.

Phono ground terminal.

3) An M3 knurled thumbscrew is supplied with your kit. Screw it into the GND terminal at the back of the chassis. (see figure 28 “ground screw”) This screw is used to attach the ground lead of your record player.

Interconnection of the audio boards.

4) Please refer to figure 28. You will notice ten short interconnecting wires between the audio PCB’s displayed in red. Please use short pieces of the supplied non insulated wire for these. Form little arcs from this wire ensuring that they don’t touch the adjacent wires.

5) Displayed in green you will notice the safety GROUND lead between the input PCB and the ground terminal next to the mains input terminal. Take a piece of 7 cm of the green/yellow striped wire. Feed it through the hole in the partition and mount both sides very carefully, remember first hook it in, bend flat and then solder carefully. Connection of this wire is very important for safety reasons, please pay attention to this.

STEP 23 – final assembly –
power supply & headphone terminal

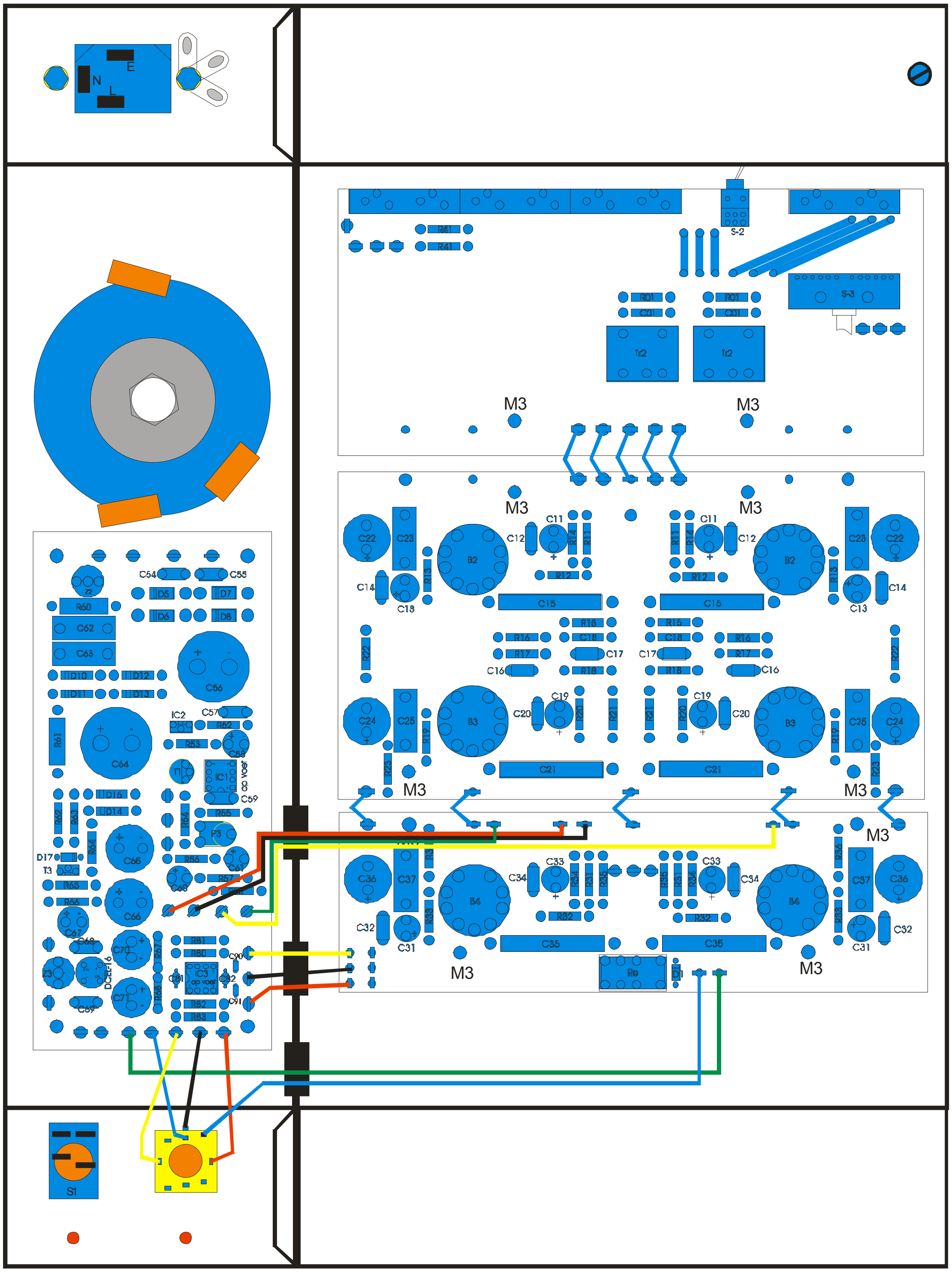

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Figure 29

Interconnection of power supply and audio boards.

1) The four leads of the filament and high voltage supply are displayed in figure 29. Feed these through the hole in the partition next to transistor T2.

2) The filament supply leads are colored green and yellow, the high voltage lead is red, the ground lead black. Solder these leads to their terminals as shown in the figure.

3) Tie these leads together with cable ties neatly and horizontally above the line PCB.

Interconnection leads of the headphone amplifier.

4) The headphone amplifier (IC 3) is located on the power supply board and is connected to the line circuit board by means of three leads coloured yellow, red and black each 4cm long (see figure 30). Feed the leads through the partition and solder them to their terminals.

5) Prior to mounting the headphone input socket it is advisable to first solder all the leads to it whilst it is accessible. Please study figure 30 carefully. The ground terminal is situated at the outer front of the socket; solder a 6cm length of black wire to it. All the other terminals are situated at the rear of the socket and are numbered 1 - 8. Solder a 22cm length of blue wire to terminal “1”, a 6cm length of blue wire to terminal “2”, a 6cm length of red wire to terminal “8”and finally a 6cm length of the yellow wire to terminal “4”. Since the solder terminals on the power circuit board will eventually be hidden under this headphone socket it is also more convenient to solder all of the wires to these PCB terminals before mounting the socket to the front of the chassis.

6) Solder a 24cm length of green wire to its terminal on the power circuit board. Feed this wire together with the long blue wire from the headphone socket through the front hole in the partition. Solder both leads to the terminals next to relay Re on the line circuit board as shown in figure 30. These two leads together with an internal switch in the headphone socket enable relay Re to switch over the audio signal from the usual signal path to the headphone amplifier when a headphone jack is connected to the front terminal.

7) Finally firmly mount the headphone socket in position as shown in the figure.

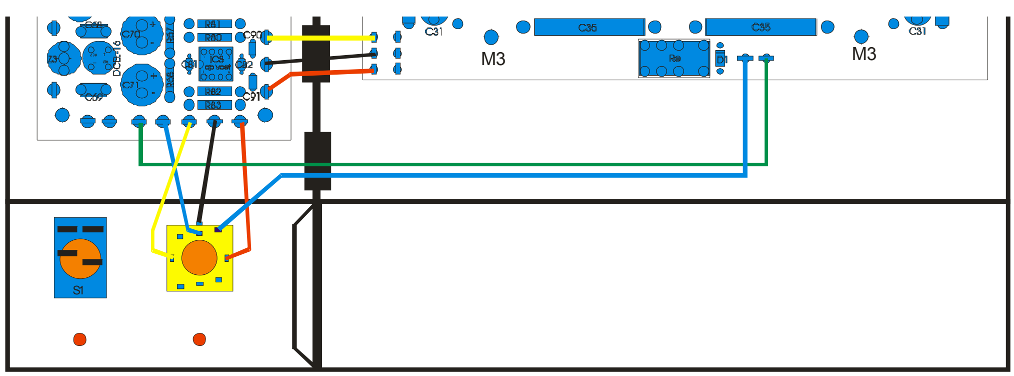

Figure 30

Function of the LED above the headphone terminal.

8) There is a little hole in the front panel just above the headphone terminal; this is for the yellow LED supplied with the kit. The function of this LED is not specified and neither does it appear on the circuit diagram. It is up to the constructor of the amplifier to decide what to do with it, for instance it can be used with the 24V supply and the remaining switch of the headphone socket.

9) Figure 31 shows two examples.

   Example 1: If the yellow LED is connected in series with a 3300 Ohm resistor (soldered to the long terminal) & to the 24V supply then the LED will light up when a jack plug is connected to the headphone terminal. Take a 7cm length of narrow heatshrink and slide it over both the longest terminal of the LED as well as the entire length of the series resistor and solder to the correct terminal on the power PCB. Slide a 4 cm length of heatshrink over the shorter terminal of the LED and solder it to terminal “6” of the headphone socket. Solder a length of wire between terminal “5” of this socket and the PCB terminal.

   Example 2: The yellow LED can be powered by the high voltage supply, connected in series with a 150V Zener diode and a 10,000 Ohm resistor. The brightness will gradually increase in approx. 15 seconds after the power is switched on simultaneously with the ramping up of the high voltage supply. It is very important to use heatshrink (the narrow kind) for isolation. Slide a 10cm length over the longest terminal of the LED, Zener diode and resistor and a 4cm length over the shorter LED terminal. Note that you will need to lengthen the leads with appropriate lengths of wire before sliding the heatshrink over and solderering both to their PCB terminals as shown in figure 31.

   (all of the parts for these two examples are supplied with your kit)

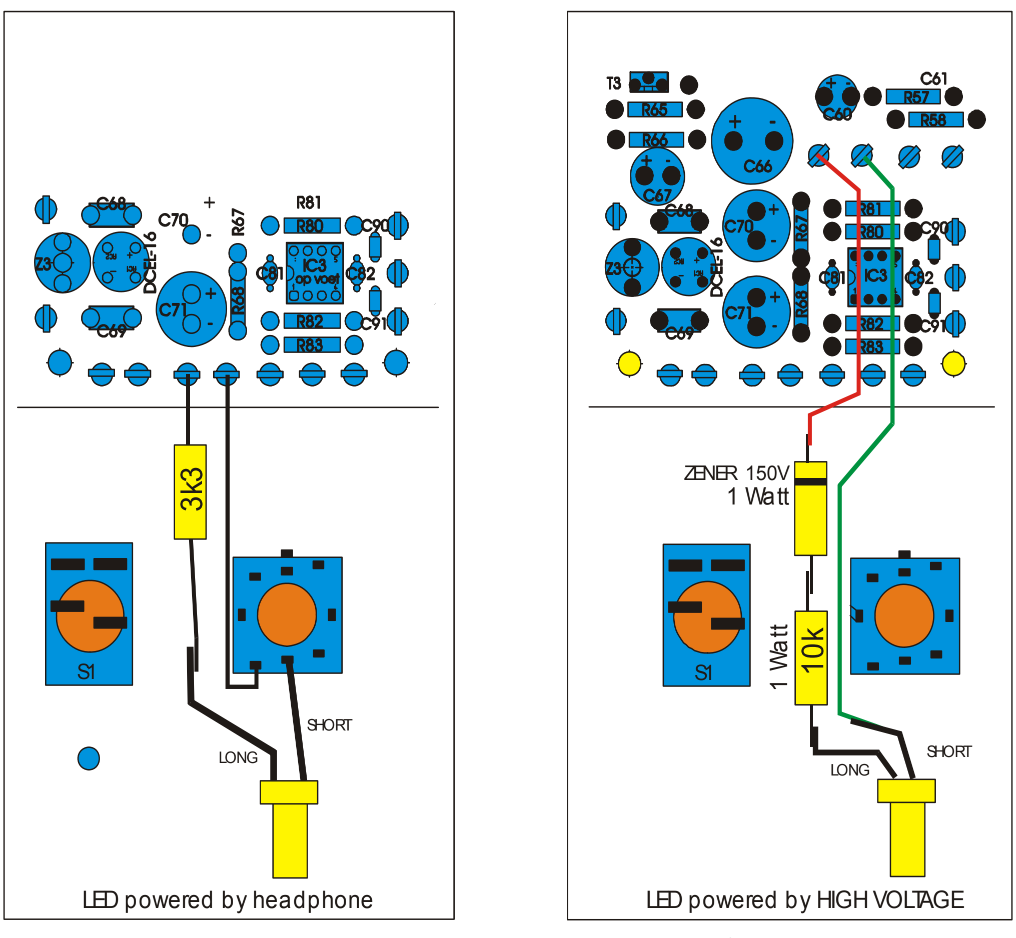

Figure 31

STEP 24 – final assembly – leads for audio signal path

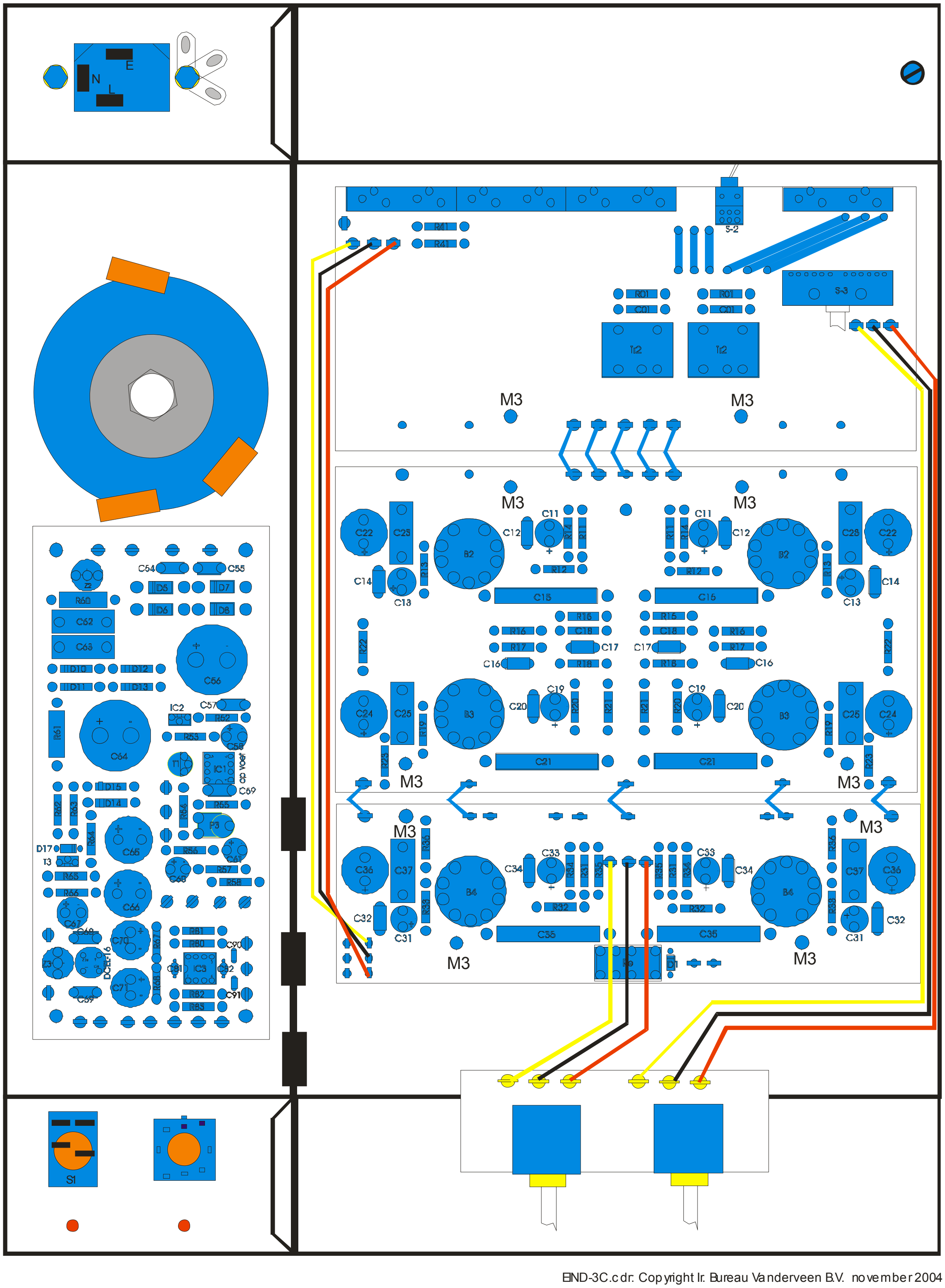

Figure 32

1) Mount the control circuit board into the chassis as shown in figure 32. This PCB with control pots will be fixed using the two nuts and washers supplied with the Alps controls.

2) High purity Siltech G5 gold injected silver-wire is used for the signal path wiring. This 0.5 mm wire is isolated with a material called Kapton. This double layer of Kapton has to be scraped off from both ends of each lead before it can be soldered. Take care when removing these layers; the silver wire is soft whilst the Kapton is very tough. It is advisable to practice this before cutting the silver wire into the prescribed lengths.

3) The silver wire supplied with your kit comes in one length and is a brownish colour. In figure 32 you will find three colours displayed for the sake of clarity. Red is used for the right channel, yellow for the left and black for the ground leads. It might be convenient to mark both ends of each lead with a felt tip pen, to avoid having to check each connection with an ohmmeter prior to soldering.

4) Start with three 13cm lengths for soldering between the control circuit board, just behind the volume-pot and the line-PCB. Slide one length of 6cm of narrow heatshrink over these three wires.

5) Next make the connections between the input selector switch S1 and the control circuit board. You will need three 32cm lengths of silver wire and one 25cm length of heatshrink to hold them together. Position these leads as shown in figure 32.

6) Use three 27cm lengths of silver wire and one 20cm length of heatshrink to connect the line-PCB with the input – PCB. These leads actually go the to the amplifier output terminals. Position them neatly along the partition as shown in the figure.

STEP 25 – final assembly – valves and cabinet

1) Insert the shaft support into the front of the cabinet and fasten in place with the nut. Push the input selector shaft extension through the support in the cabinet; slide both shaft couplings over the shaft. Now connect the extension shaft to the shaft of the input selector by tightening the two screws of the first coupling. We advise you to use a file to slightly flatten the aluminum shaft at the spot where the coupling is to be mounted. The screw will hold better on a flat surface, providing a more reliable connection in the long term. The shaft of the selector is made of softer material and does not require flattening. Slide the second shaft to the front of the extension leaving approximately 1mm space between the coupling and the support and then firmly tighten the two screws. This prevents the shaft from being pulled out which would cause damage to the selector. (see figure 33)
2) Slide the white nylon washer over the extension shaft and push on one of the two small knobs so that there is just less than a 1mm gap between the knob and washer. Next tighten the screw in the knob. The white washer prevents damage to the input selector if someone pushes or something bumps against the knob.

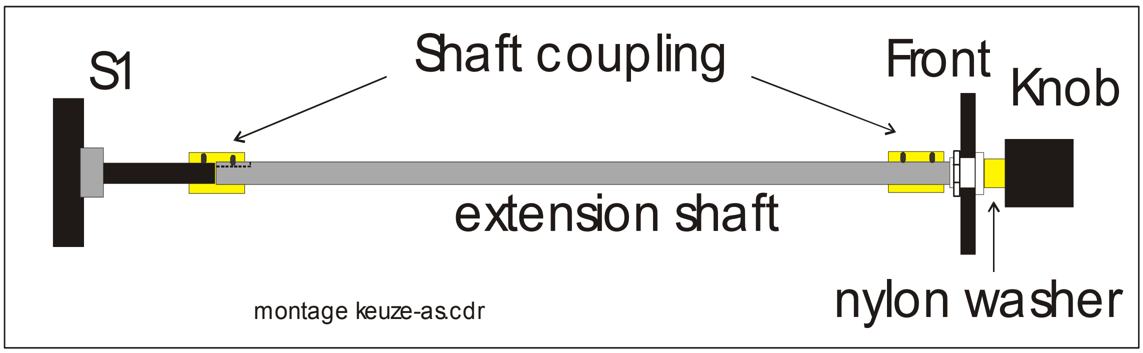

Figure 33

3) Push the second small knob onto the balance control shaft and tighten the screw. A distance washer is not required here.
4) Mount the large knob onto the shaft of the volume control.
5) Screw the black ornamental nut onto the power switch.
6) Now mount the synthetic front panel using the four hexagon socket screws. Ensure that the panel fits correctly around the knobs allowing them to be turned freely.
7) Place a spot of glue to either side of each LED (super glue for instance). Push the LED's into the front panel sufficiently so that the flat surfaces of the LED's are exactly in line with the surface of the front panel. Allow the glue sufficient time to dry.
8) Plug the valves into place according figure 34.

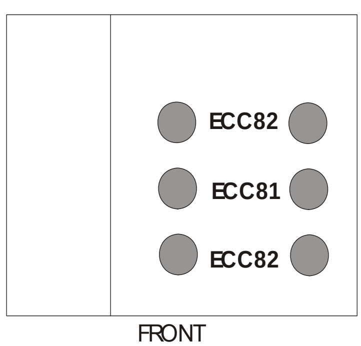

Figure 34

9) Now you can fit the cover onto the cabinet using only two M4 screws at the rear of the cabinet.

10) However it is advisable to first read the next chapter "Initial power up" as the amplifier has yet to be tested for perfect operation.

STEP 26 – initial power up -

1) Check to see if the mains fuses (250mA time-lag) are fitted in the insert of the mains input.
2) Connect a voltmeter (20VDC range) to the leads of the filament supply located at the line circuit board.
3) Plug the mains cord in.
4) Switch on the power switch and check that the red LED lights up after a few seconds.
5) Measure the filament voltage (12.6 V) and carefully adjust this voltage using the trimpot on the power circuit board. Because of the loading due to the valves now being in circuit this voltage could measure slightly lower compared with the initial check in step 21.
6) Check the high voltage supply by connecting your voltmeter with the corresponding solder terminals on the power circuit board. The meter should display around 190 to 200V.
7) Check that all of the valves have started to glow. This glowing is quite weak, so check carefully.
8) Basically your amplifier is now ready to operate.
9) Should any problems occur, please check all construction steps again and measure the voltages as shown in the diagram. If this doesn't solve your problem, you can make use of our support as described in the introduction of this manual.
10) Now connect a power amplifier and a CD player or any other source to the appropriate input of the amplifier and check that all controls function correctly.
11) Also plug a headphone in and check that it functions correctly. Please note the following advice: <u>Connect the headphone after the amplifier has been switched off for a couple of minutes and also disconnect the headphone again before you switch off the amplifier. Otherwise a loud click may possibly be heard as the high voltage supply discharges.</u>
12) If everything functions correctly you can fit the cover.
13) Make sure that there is sufficient room around the amplifier for ventilation even though there is only moderate heat generation.
14) Take care not to bump against the top of the valves as this might damage them.
15) Take care to prevent any fluids from entering the amplifier.
16) If any humming is audible in phono mode, please check if magnetic leakage of any other electrical device near the amplifier influences the MC10 transformers. Although the cabinet is made of steel and the MC transformers are surrounded with Mu-metal, strong stray fields especially from EI transformers may cause hum. If this is the case please increase the distance between the equipment. Also check that the ground connection from your record player to the GND terminal at the rear of the pre-amplifier is correct.

SPECIFICATIONS

LINE-CIRCUIT when valve B4 = 12AU7A = ECC82EH (Electro Harmonix)

Ao	=	9.2	x	(only ECC82-circuit, unloaded)
Aeff	=	3.4	x	(Vol-max, Bal-mid, Z-load = 10k)
Aeff	=	5.0	x	(Vol-max, Bal-mid, Z-load = 100k)
Zout	=	4.5	kOhm	
Zin	=	110	kOhm	(Vol-max, Bal-mid)
Zin	=	150	kOhm	(Vol-max, Bal-min)
f-3L	=	13	Hz	(Vol-max, Bal-mid, Z-load = 10k)
f-3L	=	3	Hz	(Vol-max, Bal-mid, Z-load = 100k)
f-3H	=	98	kHz	(Vol-max, Bal-mid, Z-load = 10k)
f-3H	=	363	kHz	(Vol-max, Bal-max, Z-load = 10k)
Vout-max	=	6	V_{rms}	= +16 dB_V (Z-load = 10k)
Vout-max	=	11.3	V_{rms}	= +21 dB_V (Z-load = 100k)

MD-CIRCUIT when valve B2 = 12AU7A = ECC82 and B3 = 12AT7EH = ECC81 (Electro Harmonix)

Ao	=	31		x		(1 kHz)
Cin	=	72		pF		(exclusive influence of PCB)
Zout	=	3.8		kOhm		(B2output)
Zout	=	13.5		kOhm		(B3output)
Vin-nom	=	4.8		mV_{rms}		(1 kHz for 150 mV_{rms} at the output)
Vin-max	=	=	92		mV_{rms}	(20 Hz) = + 45 dB headroom (*)
Vin-max	=	=	1.1		V_{rms}	(1 kHz) = + 47 dB headroom (*)
Vin-max	=	=	2.1		V_{rms}	(20 kHz) = + 33 dB headroom (*)
R16	=	180		kOhm		
R17	=	0		Ohm		(wire jumper)

MD-CIRCUIT when valve B2 = 12AT7EH = ECC81 and B3 = 12AU7A = ECC82 (Electro Harmonix)

Ao	=	28		x		(1 kHz)
Cin	=	170		pF		(exclusive influence of PCB)
Zout	=	13. 5		kOhm		(B2output)
Zout	=	3.8		kOhm		(B3output)
Vin-nom	=	4.8		mV_{rms}		(1 kHz)
Vin-max	=	=	88		mV_{rms}	(20 Hz) = + 45 dB headroom (*)
Vin-max	=	=	707		mV_{rms}	(1 kHz) = + 43 dB headroom (*)
Vin-max	=	=	707		mV_{rms}	(20 kHz) = + 23 dB headroom (*)
R16	=	150		kOhm		
R17	=	18		kOhm		

MD-CIRCUIT when valve B2 = 12AT7EH = ECC81 and B3 = 12AT7EH = ECC81 (Electro Harmonix)

Ao	=	89		x		(1 kHz)
Cin	=	170		pF		(exclusive influence of PCB)
Zout	=	13.5		kOhm		(B2output)
Zout	=	13.5		kOhm		(B3output)
Vin-nom	=	1.7		mV_{rms}		(1 kHz)
Vin-max	=	=	28		mV_{rms}	(20 Hz) = + 35 dB headroom (*)
Vin-max	=	=	34		mV_{rms}	(1 kHz) = + 17 dB headroom (*)
Vin-max	=	=	530		mV_{rms}	(20 kHz) = + 21 dB headroom (*)
R16	=	150		kOhm		
R17	=	18		kOhm		

(*) ref. 4.8 mV_{rms} @ 1kHz; RIAA correction (= $A_{20Hz}/A_{1kHz} = A_{1kHz}/A_{20kHz}$ = 9.5)
Design rules passive RIAA:
R1C1 = 2187,5E-6 **C1/C2** = 2,916 **R2C2** = 109,05E-6 **R1C2** = 750E-6 **R1/R2** = 6,877 **R2C1** = 318E-6

Given: C1 = 12E-9	(C16=12nF)
R1 = 182k3	(R16+R17=180k plus Zout ECC82 as first valve)
R1 = 150k + 18k	(R16+R17 for ECC81 as first valve)
R2 = 26k5	(R18=27 k)
C2 = 12E-9 / 2,916 = 4n115	(C17+C18=3n9+220p = 4n12)

EXPERIMENTS

Experiment 1 The MC-1- step-up transformer. Please refer to the MC-10 attachment at the end of this manual how to optimize the MC-10 circuit to your pick-up cartridge.

Experiment 2 The MD-phono circuit:

a) The sequence of ECC82 and ECC81 valves can be exchanged for increased input amplification and decreased noise. When B2 = ECC81 and B3 = ECC82 the MD-circuit is more sensitive for ticks and cracks on the record, but noise will be minimal.

b) With B2=ECC82 and B3=ECC81, you have maximum headroom at the input making the amplifier tick-insensitive and offering the most spatial image.

c) One could even opt for B2=B3=ECC81, for maximum amplification.

d) Another possibility is B2=B3=ECC82, this results in an extraordinary wide reproduction. The input sensitivity will be decreased, needing much more then the nominal 4.7 mV. You sacrifice loudness to gain quality.

e) When valve B2 = ECC82 then resistor replace R17 by a wire jumper (0 Ohm)

f) When valve B2 = ECC81 the values of R16 = 150k and R17 = 18k

Modifying R16/17 compensates for the difference in output impedance of valve B2. This way the RIAA curve will be followed accurately.

Experiment 3 Tuning the MD pick-up cartridge:

MD-cartridges are very sensitive, for an optimal electrical load at the input of the MD pre-amplifier, (see R11 and C10). I noticed that omitting C10 (usually 100pF) resulted in an obvious improvement in spatial reproduction in the case of my own cartridge. Experimenting with the value of R11 is also advisable; one can apply values between 22kOhm and 100kOhm. Modifying R11 inside this range will greatly influence sound reproduction. The damping of the typical resonance of your cartridge will be changed more or less, a so called critical damping being most desirable. Although most cartridges will be critically damped using a value of R11=47k, you could get more satisfactory results by experimentation.

Experiment 4 The headphone:

a) The headphone amplifier IC3a,b is currently directly wired to the headphone socket. Some headphones however require a specific amplifier output impedance, mostly in the range of 100 Ohm to 220 Ohm.

b) You can exchange the red and yellow wires for resistors, for example 220 Ohm and check for changes in sound reproduction. These changes can be for better or worse, but it might be worth experimenting.

ARTICLES

I have attached four articles to this manual which have greatly influenced the design of this amplifier. As mentioned before in the introduction I hope this amplifier will stimulate the constructor to apply his or her own ideas. But I feel obliged to hand over sufficient tools to develop, create and check these individual ideas.

The following articles will provide you with these necessary tools, and will explain many of the choices I made whist designing the MCML05 amplifier.

1) Ir. Menno van der Veen: “De Vanderveen MC-10”; manual MC-10 moving coil step-up transformer, 4 maart 2004
2) Stanley P. Lipshitz: “On RIAA Equalization Networks*1”; Journal of the Audio Engineering Society; 1979 June. Reprinted with kind permission of Stanley P. Lipshitz and the Audio Engineering Society. See also www.AES.org
3) H.R.E. van Maanen: “Compensatie van mechanische resonantie bij pick-up elementen”; Radio Elektronica 1979 ,15/16/17. Reprinted with kind permission of Hans van Maanen (only available in Dutch language)
4) H.R.E. van Maanen: “Signaalprocessor voor magneto-dynamische pick-up elementen”; Radio Elektronica 1980, 19. Reprinted with kind permission of Hans van Maanen (only available in Dutch language)

LITERATURE

The amount of literature that I consulted is immense, a study that took my entire life and still continues. It makes no sense to mention every consulted book. It is better to sum up the “highlights” which are still available. This includes the so called “Anthology Series” and “Proceedings of Conferences” of the Audio Engineering Society. These Anthologies and Proceedings can be ordered at www.AES.org . The following ones are important concerning the MCML05:

1) Disk Recording VOL.1: Groove Geometry and the Recording process; edited by Stephen F. Temmer
2) Disk Recording VOL.2: Disk Playback and Testing; edited by Stephen F. Temmer
3) Stereophonis Techniques; edited by John M. Eargle
4) The Proceedings of the AES 8th International Conference: THE SOUND OF AUDIO, Washington, D.C., 1990 May 3-6
5) Moderne High-End Buizenversterkers-2; Menno van der Veen; Segment b.v.