4-WATT PLL PRO IV HI GAIN

PROFESSIONAL EXCITER

CONSTRUCTION GUIDE

OVERVIEW

The PLL PRO IV High-Gain is a very high quality phase-locked-loop based transmitter. Frequency stability and spectral purity were major factors in the design process and achieve the highest standards. **NRG** have a policy of continual design and development, and this unit is the product of an extensive design process and exhaustive testing.

The circuit can be examined in the attached schematic diagram. You will see that there are essentially two sections – the transmitter and the logic. The transmitter has a unique oscillator design, wich eliminates the need for a separately aligned frequency multipler stage, even though signal generation is at half of the output frequency , wich eliminates RF feedback and hum problems associated with "at frequency" designs. The next two stages are are amplifiers. The gain profile of these can be fine adjusted by the user to yield an output from 0 to 4 watts via an on-board variable controller. A lowpass filter follows the output stage to ensure exceptional spectral purity. The logic side of the board is a phase-locked-loop with a pre-settable divider for output frequency setting. The frequency is selected from BCD switches eliminating the need for a lookup table as found in previous versions such as the PRO 3. A new additional function of this model is Tuning indicator PL1 (which is an additional circuit) and output power adjustment VR2.

The printed circuit board layout has been carefully designed to give reliable and consistent results. If you follow the simple construction details accurately, you'll easily build this high specification FM transmitter.

Please read fully before construction starts

First, check that the kit contains all the parts detailed in the component list.if any parts are missing or damaged, contact us immediately. Next, is your soldering of a reasonable standard and have you got a soldering iron with a tip size of 2.5mm or smaller? Onlu proceed if your answer is yes!

The **tools** you'll need are:

Side cutters; Long nose pliers; Screwdrivers; Soldering iron; Solder; Please note that you'll get better results using thin 22 SWG solder rather than the thicker 18 SWG type.

The **printed circuit board (PCB)** has a **silk screen print** on the top side. You can see **component shapes** and their **identification numbers**. With this, and the component parts list you have all you need to identify components and fit them correctly into the PCB. Take care and time to make certain that all components are correctly placed.

Some ICs may be static sensitive, so ensure that your soldering iron is properly earthed, and avoid handling the logic ICs any more than is necessary. We always use antistatic wrist straps connected to an earth point when we're constructing projects, though touching an earthed object just prior to handling an IC will discharge any static build-up on ypur body, and is almost as effective.

BUILDING STARTS HERE!

GENERAL: Separate the pages of this manual so you can clearly see this sheet, the component fitting guide, the component list and the large photograph, all at the same time. Fit the smaller components first and work your way through progressively larger components.

Remember: All components must be pushed down flat to the PCB, (unless started otherwise). The reliability and repeatability of this unit depend upon your accuracy of construction!

Use the photograph and the component-fitting guide to help you further.

1. Fit and solder the resistors (R1-R69). Identify and insert a few at a time. We have give you the colour code for each part in the Components List. When you have soldered a few components, use your side cutters to trim back the excess leads. Resistors can be fitted either way round. The two **thick film resistor** packs (TFR1 & TFR2) should now be fitted. They each have nine pins, and **must** be fitted so that the grey/white spot on the component lines up with the large wide dot on the board.

2. **Diodes** (D1-D7) and **Zener Diodes** (ZD1-ZD4) are next. Make sure you fit these the right way round. The 4 Zender diodes have a white mark on them. Remember, make sure you are still fitting components flat down to the PCB.

3. Fit and solder the integrated circuits (ICs) IC1-IC5. They must be fitted the right way round with the notch on the PCB silk screen-point. Double check they are correct before you start to solder. Solder these items carefully to avoid bridging pins with solder. Do you handle the ICs more than you need to because they are static sensitive . You should leave fitting ICs until after all the other parts, as it is easily broken off at

the legs once soldered in place. You should fit **BCD switches** SW1 , SW2 , SW3 and SW4 next.

4. Transistor TR6 next. TR8 will be pre-bonded to the PCB before it's shipped. This component (TR6) **has absolutely got tot be flat the PCB**. TR6 is a 2N4427 type. TR8 is a 2SC1947b (marked C1947). All the other transistors cannot push down fullt flat to the board, but leave them no higher than 5mm (see component fitting guide) take great care in identifying the part numbers of the small transistors – there a re four different types used, and they all have the same package outline. Fit the **LEDs** next and line up the flat section on the devices with that on the PCB silk screen. All components in this section, up to now, *must* be fitted the correct way round. An error could damage some parts, and the unit would certainly not work. Fit VCD1 next noting that this item *can* actually fit either way round.

5. At this stage hold the board under bright light and check that you have soldered every component connection so far in the PCB. Also check that connections close to each other aren't bridged with solder. Are all the parts flat to the board?

6. Now fit the **variable resistor** VR1, VR2 followed by the capacitors C1-C70. Have a look at the component fitting guide for help on fitting capacitors to the PCB. **Remember**, fit the parts flat (or very close) to the PCB. Make sure that you fill all the **electrolytic** capacitors the correct way round – they have polarity identification markings.

7. Fit the **coils** L1-L7 next. We again have to remind you: as with most other parts, push this coils fully down to the PCB. Take care with the fragile coils 2 and RFC1 though. RFC1 must have a ferrite bead slipped over just go through the middle of the beads, so it standards a little way off the board.

8. Right, it's time to hold the PCB under the bright light again and check your work carefully for joints you have missed with your iron and also solder splashes.

9. Now fit and solder the rest of the parts, taking a regular glance at the component fitting guide pictures. The two fuse holder clips have to be fitted the correct way round or the fuse won't fit. Take care with Trimmer Capacitor VC1. Be careful that you do not catch your soldering iron on the thin film separating the vanes on this part, it is easily done. Solder ahe red and the black wire to the+and-pads (underside and close to FB1 & FB2) wich the red wire to+. The last part to fit is IC6, a 3 pin IC. It cannot push flat to the board because of stepsin the legs. Do not bend this component on the legs, as the leg sare brittle.

10. Now check the finished PCB by holding it up to the bright light. If you can see light shining through component holes it means you have not soldered that particular component properly, if at all. All the soldered joints should be bright and shiny – a dull joint usually indicates a "dry" joint. Check all the ICs to may shure they are in the right places and the right way round. Check that all the electrolytic capacitors are the correct way round and also double-check the transistors and diodes. If a soldered component, like an IC has to be removed, you will need a de-soldering pump to do it correctly.

11. You can now fit the heatsink to the output transistor TR8. Look at picture 1 on the component-fitting guide. Make sure you push the heatsink vertically down onto TR8, **with no sideways pressure**. This transistor can be a little fragile, so please take care. That's it.

12. Now, does your finished PLL PRO IV look anything like the one in the large photograph? Well, we hope so!

Note: NEVER operate your transmitter without a proper load connected to the output – either a dummy load or a correctly matched aerial. Failure to do so could result in the destruction of your output transistor!

SWITCH ON TIME

1. Connect the Plug type 50-ohm dummy load (supplied with this kit) to the RF output SO239 socket. Set the trimmer capacitor ,VR2 and VR1 to their mid positions with a small flat blade screwdriver.

Note: The dummy load should not be used for periods longer than 30 seconds when the transmitter is at full power!

2. Set the four 10-way BCD switches to the required frequency using the numbers written on them, and set VR2 to mid position, so that the unit is set to 2 Watt output.

Note: For 101.50 Mhz set SW1 on 1 , SW2 on 0 , SW3 on 1 and SW4 on 5

3. Connect the red/black power input wire to a regulated 13.8-volt supply. Absolute maximum supply voltage is 15volts.

4. Adjust VC1 until the red LED3 (unlock) starts to dim. Continue until the green LED4 suddenly illuminates and the red LED goes out altogether. The unit is now locked on your programmed frequency. A second or so later, LED1 will light indicating RF output. Turn the power off for a few seconds, and then re-apply the power. Re-adjust VC1 if the unit does not lock when you switch back on. Lock up should take 3-5 seconds from switch on.

Note: you can bypass the out-of-lock power down by fitting J2.

There will be no output power indication until the PLL locks, unless J2 is fitted. This is a protection feature which prevents the transmitter operating on the wrong frequency. The output power LED will illuminate about a 5 seconds after the green 'lock' LED comes on.

5. Connect audio at line level to the WM2 MPX INPUT socket. Whilst listening on a FM radio, adjust VR1 for the correct sound level – you can compare with other stations.

6. An aerial can now be connected to the RF output socket and your signal will be radiated. The aerial should have an impedance of 50 ohms at the frequency you want to use, and the feeder should also be a 50 ohm type. You can consult us if you need help or advice about aerials.

7. Adjust your required power output level. If you require 4 Watts, turn VR2 to maximm level , if you want 2 Watts set VR2 to the middle position.

8. Finally, a note on pre-emphasis. You have three choices with this unit – 75 uS for the Americas, 50 uS for the rest of the world , and 'none' if you use a stereo coder and/or a limiter compressor unit the PLL PRO IV. You can make your selection with the push – fit jumper J1 near to VR1.

PROBLEMS?

If the unit does not work when you first swiych on, then the first thing to is to carefully re-check your entire construction and component placement. It is unlikely that any parts supplied wew faulty to start with, although not unheard of.

1. No life in the unit at all. It could be your power supply unit – is the power LED lit? check that the red/black power supply wire is wired to the PCB correctly with the red wire going to positive terminal pin – reverse connection will blow the fuse. Finally, try fitting a replacement 1amp fuse.

2. Buzz on the sound. This is probably RF getting into your audio equipment from the transmitting aerial.the transmitting aerial must be above the building and not inside the building. If you disconnect the audio source from the PLL and the buzz goes away then the audio equipment is certainly picking up RF. If the buzz is still there , then your power supply probably has a lot of ripple on its output.try another power supply. Also realise that some receivers buzz anyway when they are close to a transmitter, due to overloading. A good car radio is often best for checking for buzzing.

3. Unstable performance. Too many components stood up on long legs above the PCB. Dry soldered joints or joints missed completely.

COMMON CONSTRUCTION ERRORS

1. One or more LEDs fitted wrong way round
2. One or more diodes fitted wrong way round
3. Transistors fitted in wrong location
4. ICs fitted in wrong location
5. IC pins bridged with solder
6. Centre pin of SO239 not soldered
7. Joints not soldered at all
8. Very poor soldering quality
9. Solder splashes

You can check the soldered joints better with a magnifying glass and also find shorted tracks. A multimeter is also very handy at locating shorted or broken tracks.

This is a complex circuit, so if it is not working correctly after you have built it, please do not panic! Give us a call for advice on what to do next.

THE NEXT STEP

We would recommend that any transmitter be properly cases in a metal box. This ensures that the unit cannot suffer from interference from local sources, and protects against damage. There are mounting holes provided in the corners of the PCB, to make assembly into a case easy.

You will have to use appropriate audio, power and RF sockets. We would recommend keeping the power supply separate, as this prevents the problems associated with power supplies in the same box as a transmitter!

If you need advice about mounting your transmitter into an enclosure, you can contract us.

Check our website, or contact us for details of new products and add-ons to your transmitter. NRG continually develop new products, and improve existing ones – modifications will be posted to the website.

PLEASE NOTE THAT YOU MAY NEED A LICENCE TO OPERATE A RADIO TRANSMITTER .

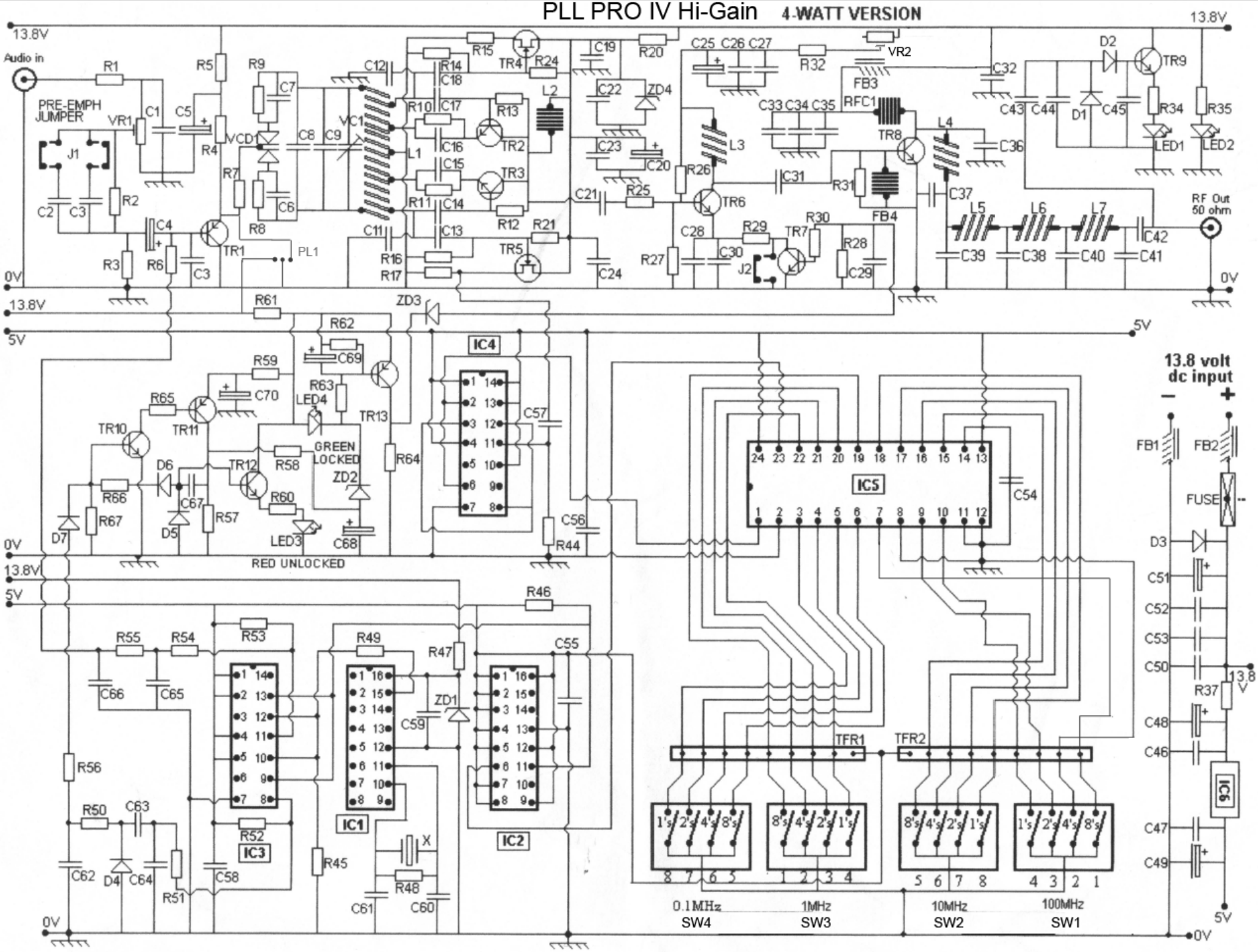
NEW COMPONENT LIST FOR 4 WATT PLL PRO4xxx

R1	47R	yellow purple black gold
R2	33K	orange orange orange gold
R3	8K2	grey red red gold
R4	10K	brown black orange gold
R5	3K3	orange orange red gold
R6	100K	brown black yellow gold
R7	6K8	blue grey red gold
R8	4K7	yellow purple red gold
R9	4K7	yellow purple red gold
R10	270	red purple brown gold
R11	270	red purple brown gold
R12	68K	blue grey orange gold
R13	68K	blue grey orange gold
R14	1M	brown black green gold
R15	560	green blue brown gold
R16	1M	brown black green gold
R17	560	green blue brown gold
R18	0R	single black band
R19	0R	single black band
R20	120R	brown red brown gold
R21	2M7	red purple green gold
R22	0R	single black band
R23	0R	red red brown gold
R24	2M7	red purple green gold
R25	5R6	green blue gold gold
R26	6K8	blue grey red gold
R27	4K7	yellow purple red gold
R28	15K	brown green orange gold
R29	15R	brown green orange gold
R30	680R	blue grey brown gold
R31	68R	blue grey black gold
R32	10R	brown black black gold
R33	0R	single black band
R34	330R	orange orange brown gold
R35	2K7	Red purple red gold
R36	0R	single black band
R37	33R	orange orange black gold
R38	0R	single black band
R39	0R	single black band
R40	0R	single black band
R41	0R	single black band
R42	0R	single black band
R43	0R	single black band
R44	4K7	yellow purple red gold
R45	4K7	yellow purple red gold
R46	1K5	brown green red gold
R47	470R	yellow purple brown gold
R48	100K	brown black yellow gold
R49	1K5	brown green red gold
R50	12K	brown red orange gold
R51	5K6	green blue red gold
R52	1K5	brown green red gold
R53	1K5	brown green red gold
R54	10K	brown black orange gold
R55	22K	red red orange gold
R56	12K	brown red orange gold
R57	270R	red purple brown gold
R58	560R	green blue brown gold
R59	33R	orange orange black gold
R60	56R	green blue black gold
R61	15R	brown green black gold
R62	18K	brown grey orange gold
R63	10K	brown black orange gold
R64	1K5	brown green red gold
R65	2K2	red red red gold
R66	5K6	green blue red gold
R67	47K	yellow purple orange gold
R68	0R	single black band
R69	0R	single black band
TFR1	2K2	x8 222J
TFR2	2K2	x8 222J

C1	100pF	101J
C2	1.5nF	152
C3	2.2nF	222
C4	10uF	10uF 16V
C5	47uF	47uF 63V
C6	100pF	101J
C7	56pF	56J
C8	56pF	56J
C9	22pF	22J
C10	22pF	22J
C11	1.8pF	1.8C
C12	1.8pF	1.8C
C13	22pF	22J
C14	27pF	27J
C15	1nF	102
C16	1nF	102
C17	27pF	27J
C18	22pF	22J
C19	1nF	102
C20	220uF	220uF 16V
C21	33pF	33J
C22	1nF	102
C23	10nF	103
C24	1nF	102
C25	47uF	47uF 63V
C26	10nF	103
C27	1nF	102
C28	100pF	101J
C29	1nF	102
C30	220pF	221J 100V
C31	56pF	56J
C32	1nF	102
C33	1nF	102
C34	10nF	103
C35	100pF	101J
C36	5.6pF	5.6C
C37	33pF	33J
C38	56pF	56J
C39	27pF	27J
C40	56pF	56J
C41	27pF	27J
C42	1nF	102
C43	1.8pF	1.8C
C44	5.6pF	5.6C
C45	1nF	102
C46	1nF	102
C47	1nF	102
C48	2.2uF	2.2uF 63V
C49	2.2uF	2.2uF 63V
C50	100nF	.1k63 or 100nK63
C51	220uF	220uF 16V
C52	10nF	103
C53	1nF	102
C54	100nF	.1k63 or 100nK63
C55	100nF	.1k63 or 100nK63
C56	100nF	.1k63 or 100nK63
C57	1nF	102
C58	100nF	.1k63 or 100nK63
C59	100nF	.1k63 or 100nK63
C60	33pF	33J
C61	100pF	101J
C62	4.7nF	4n7K100 or 4n7J 100
C63	220nF	.22K63 or 220nK63
C64	10nF	10nFk63 or 10nK100
C65	220nF	.22K63 or 220nK63
C66	100nF	.1k63 or 100nK63
C67	10nF	103
C68	220uF	220uF 16V
C69	1000uF	1000uF 16V
C70	220uF	220uF 16V

VC1	40pF	Purple Trimmer
VR1	10K	Variable Resistor
VR2	1K	Variable Resistor
IC1	4060B	4060B
IC2	74LS76	74LS76
IC3	74LS86	74LS86
IC4	74ALS74	74ALS74
IC5	HC4059B	HC4059B
IC6	L7805	7805
TR1	BC558B	C548B
TR2	BF199	F199
TR3	BF199	F199
TR4	BF245	245C
TR5	BF245	245C
TR6	2N4427m	2N4427
TR7	BC548C	C548B
TR8	2SC1947	C1947
TR9	BC548C	C548B
TR10	BC548C	C548B
TR11	BC558B	C558B
TR12	BC548C	C548B
TR13	BC558B	C558B
LED1	5mm GREEN	Hi-Bright Led
LED2	5mm RED	Hi-Bright Led
LED3	5mm RED	Hi-Bright Led
LED4	5mm GREEN	Hi-Bright Led
X	AEL 6.4000 Mhz	CRYSTAL
D1	1N4148	4148
D2	1N4148	4148
D3	1N5402	1N5402
D4	1N4148	4148
D5	1N4148	4148
D6	1N4148	4148
D7	1N4148	4148
ZD1	BZX7V5	7V5 white spot
ZD2	BZX7V5	7V5 white spot
ZD3	BZX7V5	7V5 white spot
ZD4	BZX7V5	7V5 white spot
VDC1	KV1330	330
SW1	BCD switch	MCRH2AF
SW2	BCD switch	MCRH2AF
SW3	BCD switch	MCRH2AF
SW4	BCD switch	MCRH2AF
FB1	5turn Ferrite Bead	
FB2	5turn Ferrite Bead	
FB3	5turn Ferrite Bead	
FB4	5turn Ferrite Bead	
L1.x	6 x 2 turn coil 5mm i.d. (1.2 mm)	
L2	6 turn small coil 4 mm i.d. (0.5mm)	
L3	3 turn coil 5.5 mm i.d. (1.2mm)	
L4	4 turn coil 4.5 mm i.d. (1.2mm)	
L5	5 turn coil 6 mm i.d. (1.2mm)	
L6	5 turn coil 6 mm i.d. (1.2mm)	
L7	5 turn coil 6 mm i.d. (1.2mm)	
2 x	Loose Ferrite Bead	
RFC1	RF CHOKE (0.4mm on 2.2k /1W)	
FUSE:	2 x 20mm fuse clips + 1A fuse	
J 1	3 pin Pre-emphasis Jumper	
J 2	2 pin Jumper	
PL1	3 pin plug + removable socket	
PLL PRO 4 printed circuit board		
1 metre Red/Black Wire		
SO239	square socket	
Heatsink for TR8	SKK530	
PL259	Dummy Load	
WM1	Connector prt500	
WM2	Connector prt500	

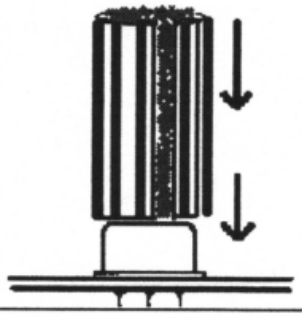
PLL PRO IV Hi-Gain 4-WATT VERSION



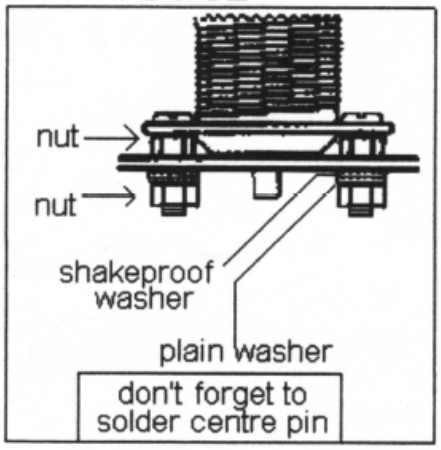
COMPONENT FITTING GUIDE

1 HEATSINK

Push the heatsink vertically onto the output transistor(TR8)

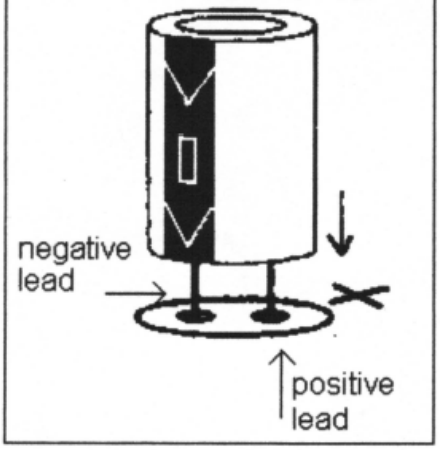


2 MOUNTING SO239 TO PCB



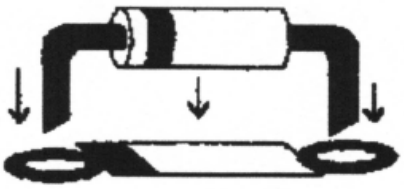
3 ELECTROLYTIC CAPACITORS

FIT IN PCB LIKE THIS AND MUST BE PUSHED DOWN FLAT TO PCB.



4 DIODES & ZENER DIODES

MUST BE FITTED THIS WAY IN PCB

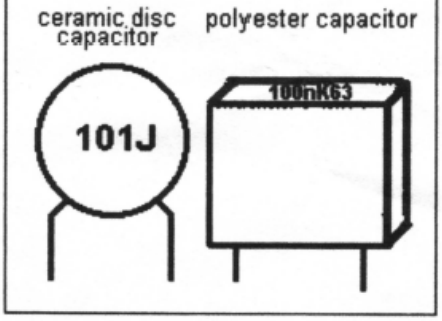


PUSH FLAT TO PCB

5 CAPACITORS

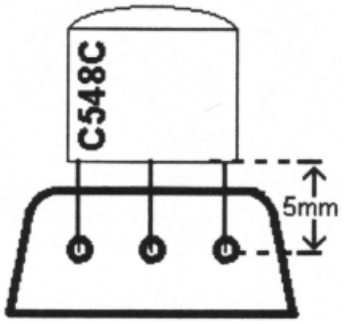
these are fitted flat to the pcb

but can fit either way in the PCB holes

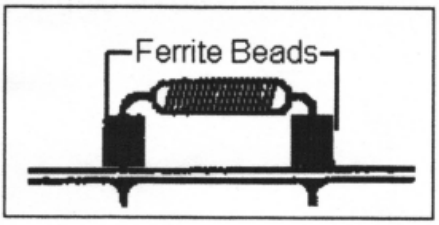


6 SMALL TRANSISTORS

MUST BE FITTED THE CORRECT WAY ROUND IN THE PCB.
THE TRANSISTOR BODY SHOULD BE WITHIN 5mm OF THE PCB

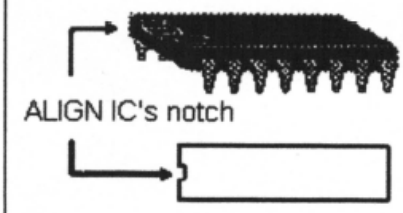


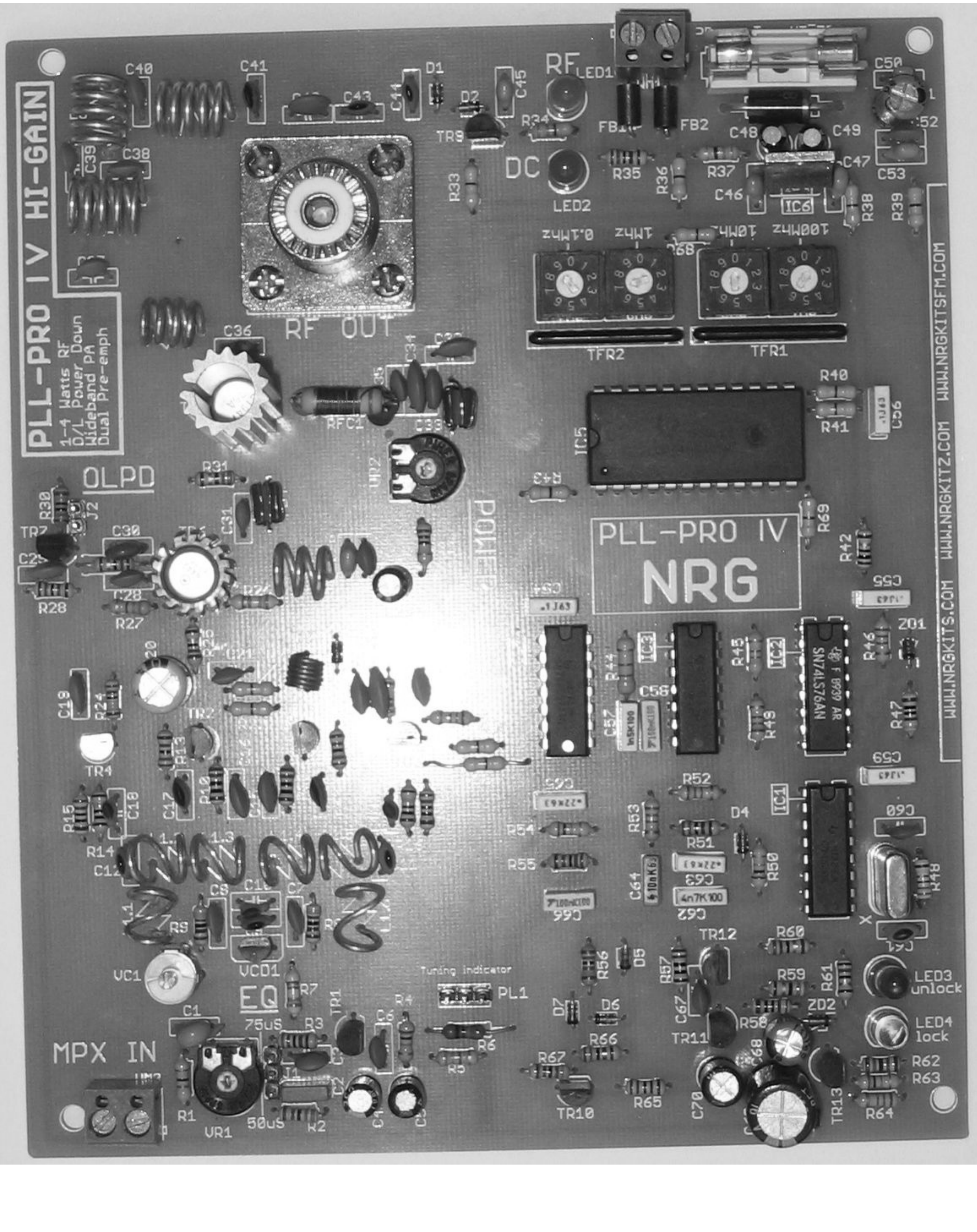
RF CHOKE (RFC1)



INTEGRATED CIRCUITS

MUST BE FITTED CORRECT WAY ROUND




PLL-PRO IV HI-GAIN
1-4 Watts RF
D/L Power Down
Wideband PA
Dual Pre-emph
RF OUT
OLPD
PLL-PRO IV
NRG
RF
DC
LED1
LED2
FB1
FB2
IC6
TFR2
TFR1
IC5
IC3
IC2
IC1
SN74LS76AN
Tuning indicator
PL1
EQ
75uS
50uS
MPX IN
VR1
VC1
VCD1
LED3
unlock
LED4
lock
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