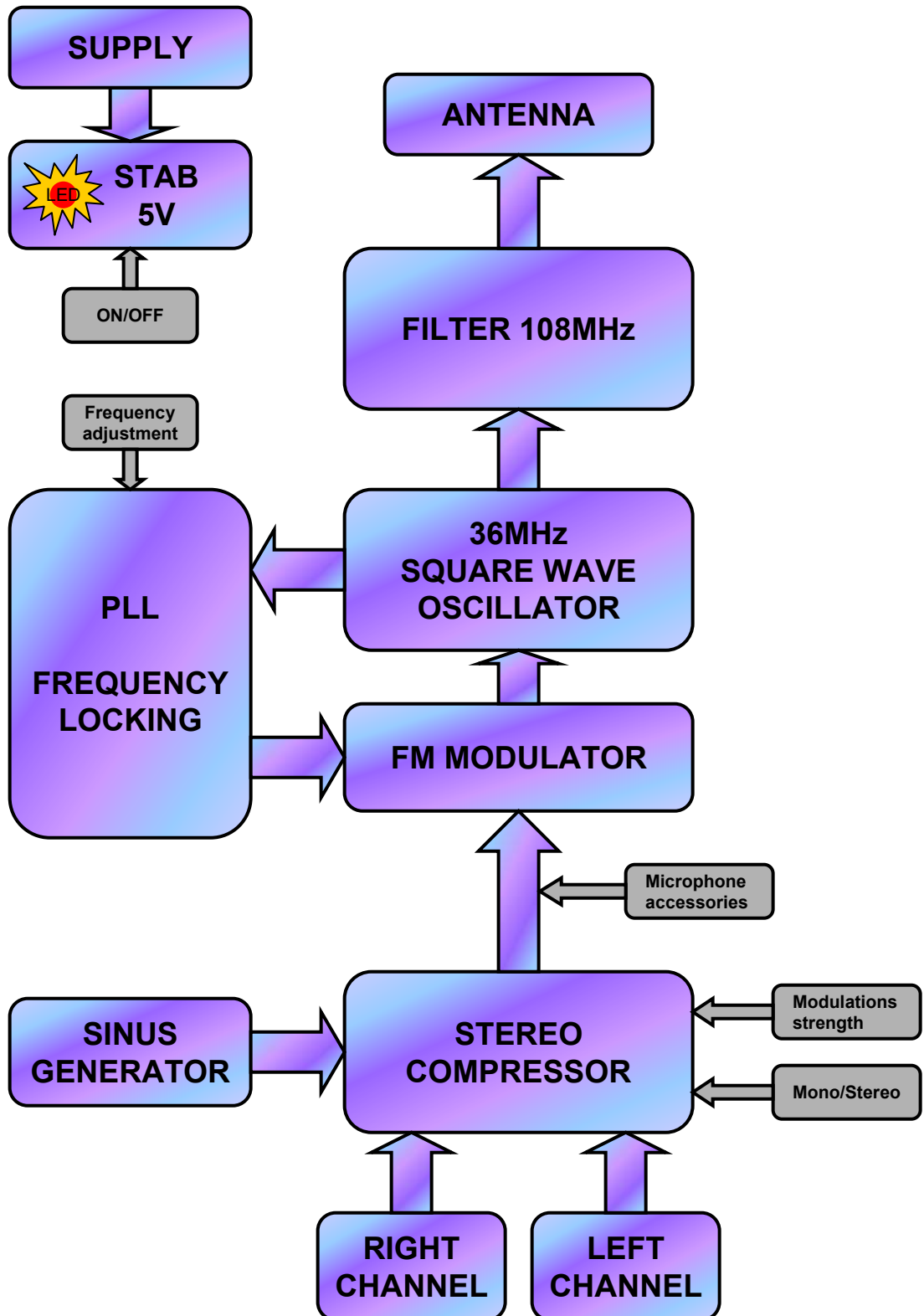


Are you an proprietor of a bigger house and is a music lover, then you sometimes can feel a need to enjoy the music from your best CD player in other rooms also. Usually we have more radio sets than stereo equipments in our abode. This radio transmitter shall be placed close to your stereo - plug it in... on the frequency 108MHz will the music be distributed, with a radius about 50 meters. Someone might want to start a radio station..!?

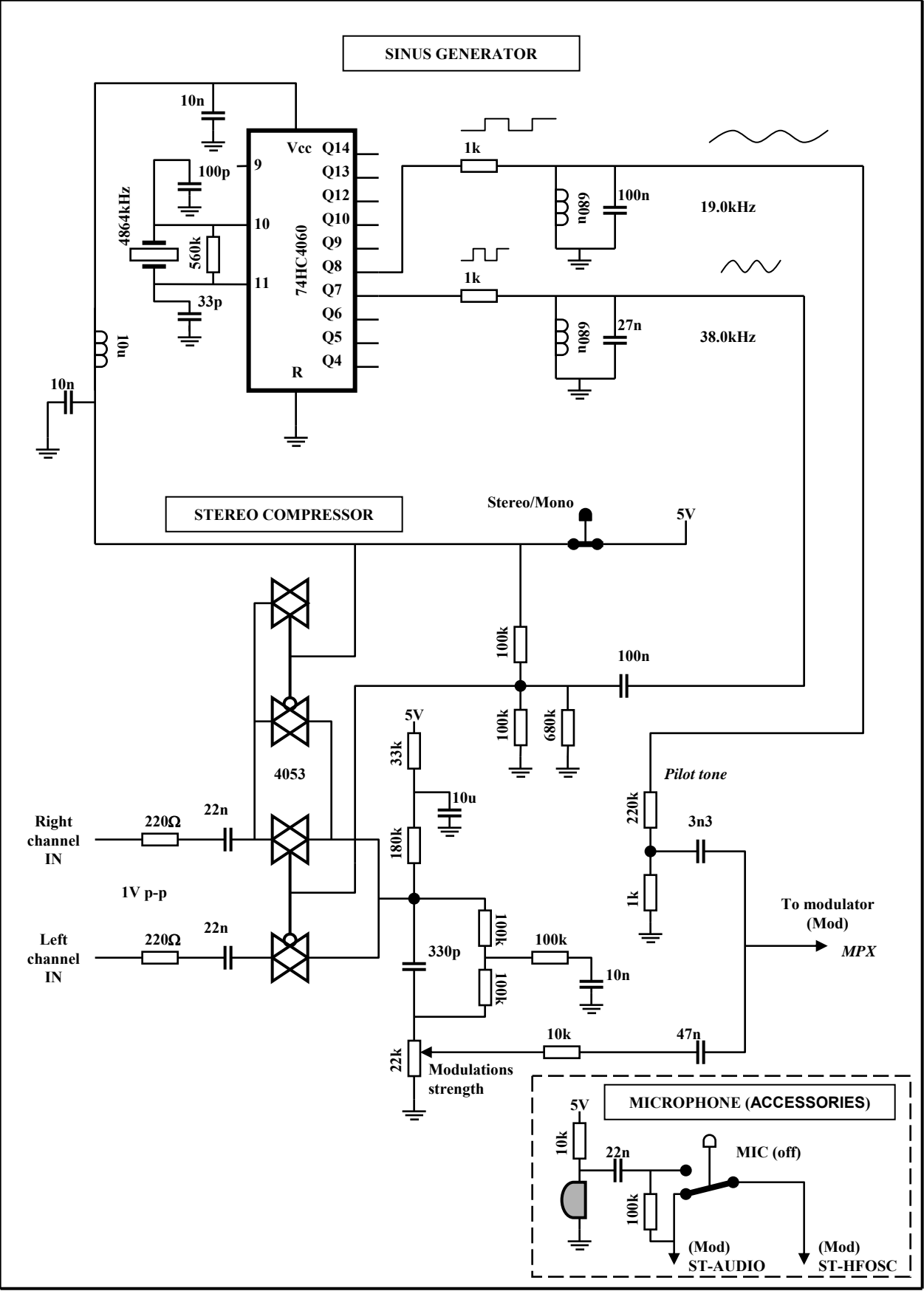
**It should be emphasized that it is not allowed to broadcast at the radio band, all of a sudden. This requires permission from the concerned authority!**

This is a medium difficulty project, both in electrical and mechanical sense. HF-building requires a good ground plane and shielding. The designs are based on two modules. One module is the FM transmitter that also is associated with the power supply. A second module converts two channel stereo to a modulation signal, a so-called MPX signal. The supply voltage is five volts for all units here. A third module contains a PLL circuit, which I can recommend. On the HF module is the possibility to tuning the frequency with a precision potentiometer, but there is a risk that the frequency will start to drift away. If you use a PLL module will that problem disappear. Note that this transmitter is not using any transistors or any operational amplifiers; instead we are using a number of logic circuits. Despite this is the hi-fi quality really promising. The only thing that may seem disturbing is that the noise level is slightly high in comparison with a professional installation. This is because the transmitter is working with the third harmonic over 36MHz and the noise from the capacitance diode will therefore be multiplied three times. The advantage is that the linearity of the modulated signal is better because it requires less amplitude of the audio signal to achieve accurate modulations strength on the oscillator. If one wishes to lower the noise, you can try a low noise diode, rather than the proposed BB132. Some types of lysis fittings, can add interference to the audio signal, like compact fluorescent lamps or neon tubes. The radio signal is taken from a logic circuit and to call this a "transmitter" is a dubious definition. The range is for this reason limited, but with a properly tuned and high-placed antenna - is the coverage very good. The unit is supplied with at least 8.5 volt DC from a power adapter or something similar. The power consumption is around 70mA. All connections between the modules are made with shielded cable, but not the feeding cables and the control voltage from ST-PLL, which may consist of common signal cables. The actual HF oscillator is completely shielded when the antenna connector are mounted directly on the screen plate and with a HF-connector of F-type.

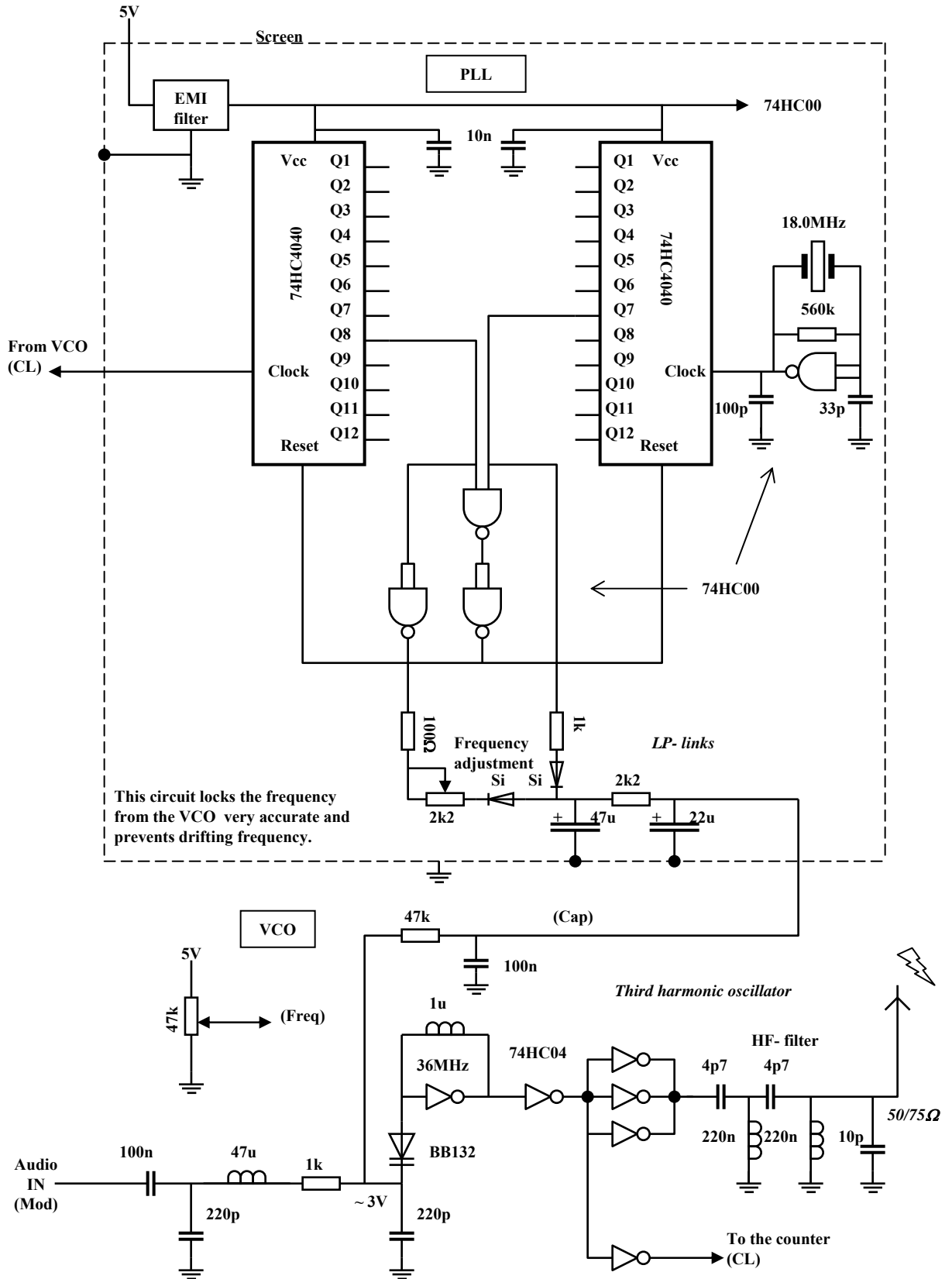
# BLOCK DIAGRAM 36HC108



SCHEMATIC OVERVIEW 1

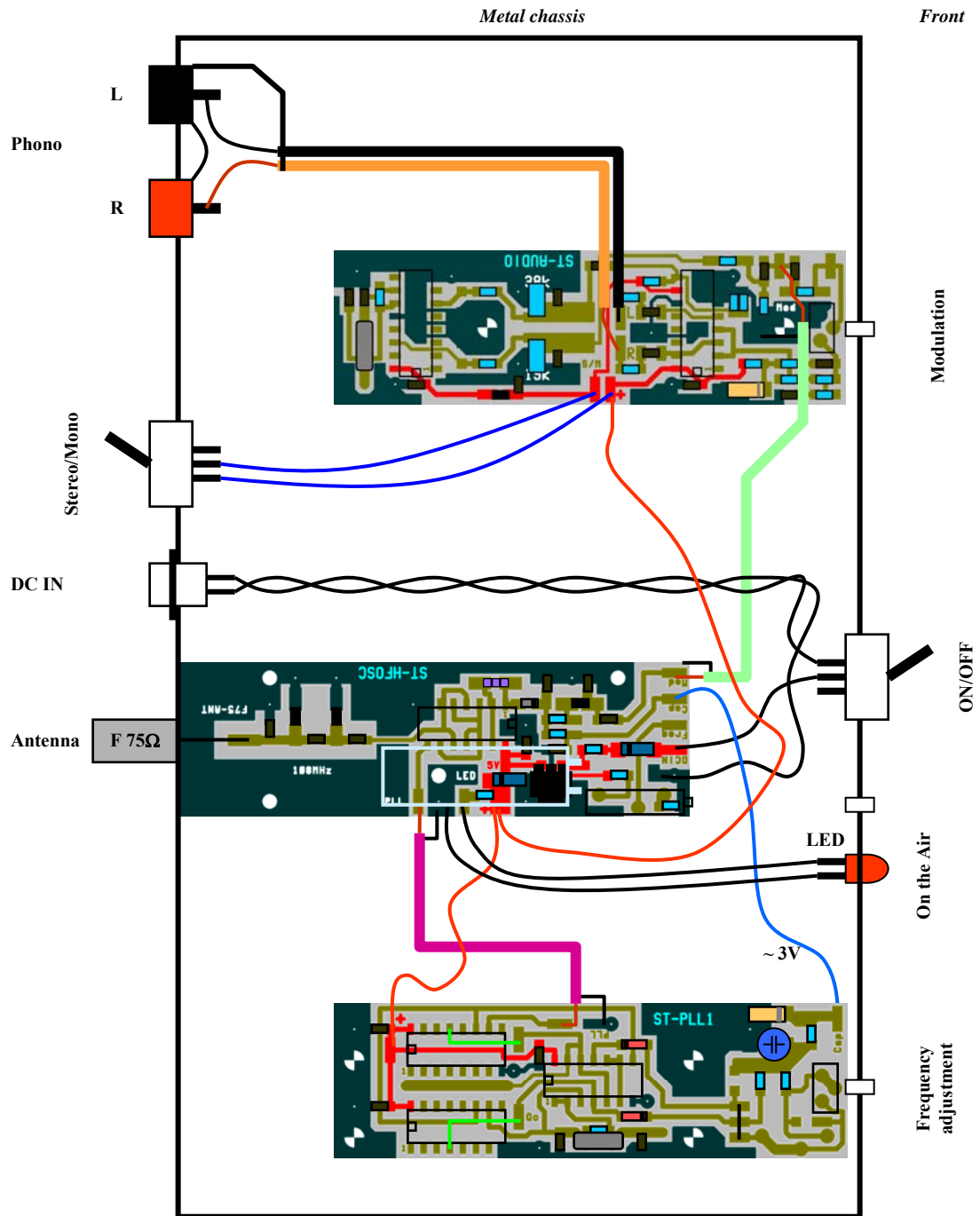


## SCHEMATIC OVERVIEW 2

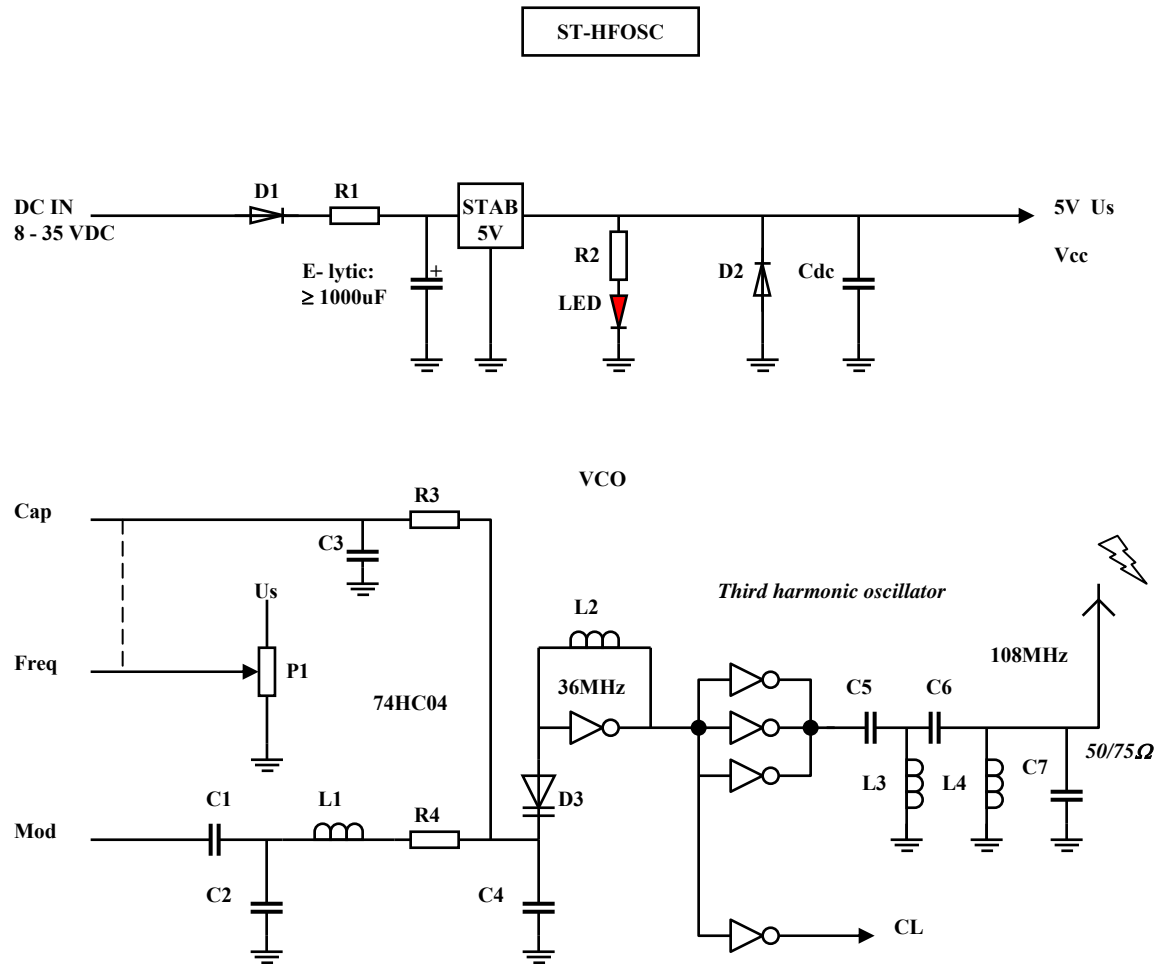


## MODULAR CONNECTORS

The figure shows all the modules (except ST-AAC and ST-MIK) plugged in an appliance box of metal. ST-HFOSC must be grounded properly in the chassis, but the other modules can hang freely. AUDIO ST and ST-PLL should be located in the front of the box so that you can set the modulation and frequency, through holes made in the front. You can attract an EMU box for the screening. EMU is the name of a sheet metal box that IKEA sells. This steel is easy to manipulate, solder at and has a nice finish.



CIRCUIT DIAGRAM



IC1 = 74HC04
IC2 = 74HC4060
IC3 = 4053B
IC4- 5 = 74HC4040 Y
IC6 = 74HC00 Y

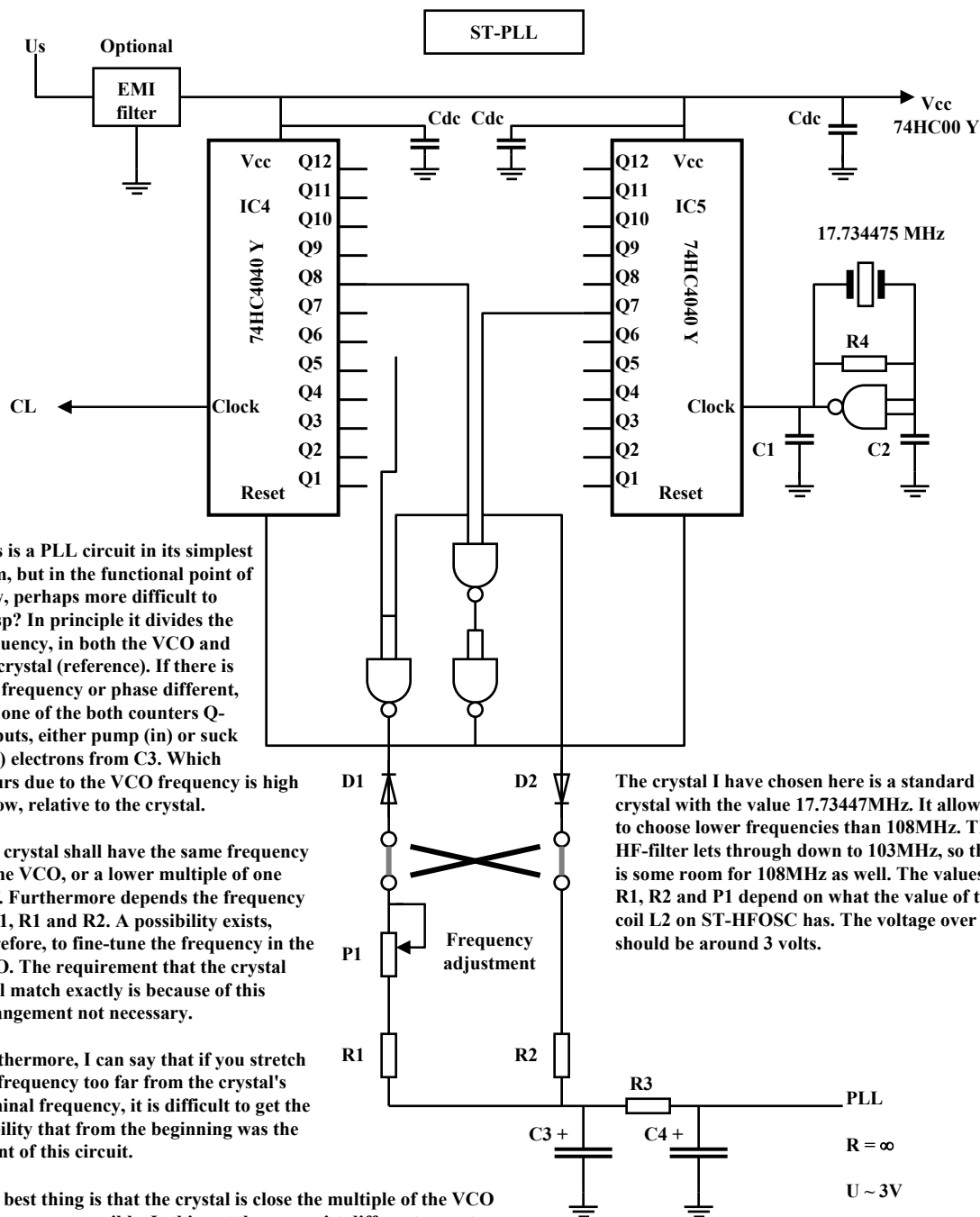
PROJECT	Stereo transmitter	
MODULE	ST-HFOSC	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
SUPPLY	≥ 8.5 VDC	< 20 VDC
CURRENT	≤ 60mA	
OTHER	-	
B. Lindqvist		2003-04

This design amplifies not the phono signal because it requires such a low voltage swing to control the FM modulator in the VCO module. Apart from this, is an arrangement of resistors and capacitors to achieve a decent sound in hi-fi class. Capacitor C8 primary task is to link in the pilot tone but C8 and R16 attenuate the upper treble register a bit. Since C11 highlights and C8 attenuates the treble, it is possible to create a platform or sharp treble reproduction without it run away too quickly.

PROJECT	Stereo transmitter	
MODULE	ST-AUDIO	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
SUPPLY	≥ 5.0 VDC	≤ 6.0 VDC
CURRENT	≤ 10mA	
OTHER	-	
B. Lindqvist		2003-04

<b>PROJECT</b>	Stereo transmitter	
<b>MODULE</b>	ST-AUDIO	
<b>MODEL</b>	36HC108	
<b>AUDIT</b>	A-3	<b>DRAWING: 1 of 1</b>
<b>SUPPLY</b>	$\geq 5.0$ VDC	$\leq 6.0$ VDC
<b>CURRENT</b>	$\leq 10$ mA	
<b>OTHER</b>	-	
B. Lindqvist		2003-04

# CIRCUIT DIAGRAM



This is a PLL circuit in its simplest form, but in the functional point of view, perhaps more difficult to grasp? In principle it divides the frequency, in both the VCO and the crystal (reference). If there is any frequency or phase different, will one of the both counters Q-outputs, either pump (in) or suck (out) electrons from C3. Which occurs due to the VCO frequency is high or low, relative to the crystal.

The crystal shall have the same frequency as the VCO, or a lower multiple of one half. Furthermore depends the frequency of P1, R1 and R2. A possibility exists, therefore, to fine-tune the frequency in the VCO. The requirement that the crystal shall match exactly is because of this arrangement not necessary.

Furthermore, I can say that if you stretch the frequency too far from the crystal's nominal frequency, it is difficult to get the stability that from the beginning was the intent of this circuit.

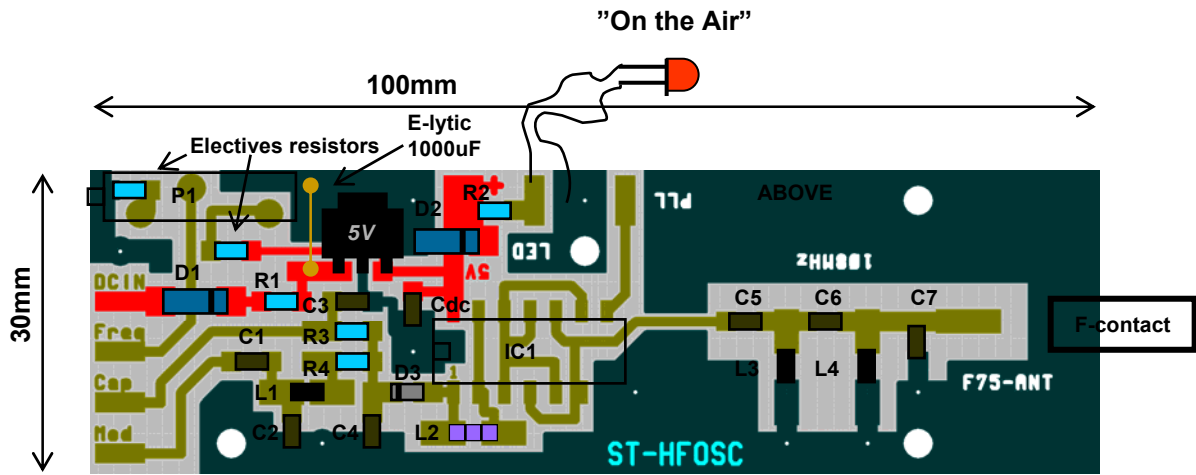
The best thing is that the crystal is close the multiple of the VCO frequency as possible. Is this not the case exist different ways to arrange P1, R1 and R2 to achieve a good frequency-setting. Tests have shown that the optimal resistance is around 2kohm for R1 and R2. A method to come to the knowledge is to set R2 to 470ohm and choose P1 to 5k. Short R1, and tune-in the right "station". Measure the resistance of P1. Replace R1 with a resistance that is close to the measured resistance. Insert a new P1 with a low resistance values. Use only SMD-resistors for best long-term stability. Keep in mind that there is a risk of interference radiation if R1 or R2 is small. If you not find the right station, you need to change the jumper. Either you could apply a II-jumper or an X-jumper. It is the choice of the resistance that counts. Adjustments can be made both above and below the crystal's nominal frequency.

The crystal I have chosen here is a standard CPU-crystal with the value 17.73447MHz. It allows one to choose lower frequencies than 108MHz. The HF-filter lets through down to 103MHz, so there is some room for 108MHz as well. The values of R1, R2 and P1 depend on what the value of the coil L2 on ST-HFOSC has. The voltage over C4 should be around 3 volts.

PROJECT	Stereo transmitter	
MODULE	ST-PLL	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
SUPPLY	≥ 5.0 VDC	≤ 6.0 VDC
CURRENT	≤ 10 mA	
OTHER	-	
B. Lindqvist		2003-04



PLACING OF COMPONENTS



SMR1206:

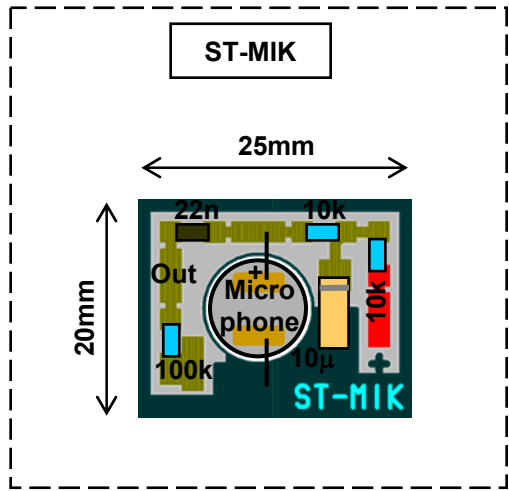
- R1 = 22Ω
- R2 = 180Ω
- R3 = 47k
- R4 = 1k

SMC1206:

- C1 = 100n
- C2 = 220p
- C3 = 100n
- C4 = 220p
- C5 = 4p7
- C6 = 4p7
- C7 = 10p
- Cdc = 10n

Other components:

- D1&D2 = LL5817, SMD
- D3 = BB132, Capacitor diode, SMD
- P1 = 47k, Precision pot.
- L1 = 47μH, Chip coil
- L2 = 1μH, 6 turns 0.5 Cu-wire, wrapped on a 4C65-toroid with Al-value=30.
- L3&L4 = 220n, Chip coil
- IC1 = 74HC04, Hole mount
- Stab. 5V = LM340MP, SMD or sim.
- LED = Red, 20mA



*This is a radio transmitter, or is it a square wave oscillator? The question is open... It works in all cases excellent for what it is intended in this project. The oscillator oscillates with 36MHz, which includes the third harmonic - 108MHz. The frequency can be changed with P1 if you make contact between "Freq" and "Cap". Otherwise you can use the ST-PLL. Since it is a clean square shape of the signal, there are many and strong harmonics available. This is sufficient to achieve radio coverage equivalent to a house or apartment. Do not try to replace 74HC04 with 74AC or 74HCU.*

Double side board. 9 marked holes shall be drilled through and to the ground plane. Four holes is for M3-screws and nuts. All components shall be handled as SMD because the ground plane do not have any tracks. The units shall be shielded with sheet metal.

PROJECT	Stereo transmitter	
MODULE	ST-HFOSC & ST-MIK	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
OTHER	-	
B. Lindqvist		2003-04

**Component List:**

<b>SMR1206:</b>	<b>SMR1206:</b>	<b>SMC1206:</b>	<b>Other components:</b>
R1 = 560k	R10 = 33k	C1 = 100p	C10 = 10μ , Tantalum
R2 = 1k	R11 = 180k	C2 = 100n	IC2 = 74HC4060 , Hole mount
R3 = 1k	R12 = 100k	C3 = 27n	L1 = 10μH , Chip coil.
R4 = 10k	R13 = 100k	C4 = 33p	L2&L3 = 680μH , Neosid
R5 = 220Ω	R14 = 100k	C5&C6 = 22n	CPU-crystal = 4864.0 kHz
R6 = 220Ω	R15 = 220k	C7 = 100n	IC3 = 4053B , Hole mount
R7 = 100k	R16 = 1k	C8 = 3n3	P1 = 22k , Standing , Cermet
R8 = 100k		C9 = 47n	
R9 = 680k		C11 = 330p	
		C12 = 10n	
		Cdc = 10n x 3	

**Notes:**

- C11 can also be a finer capacitor. For example, a poly propylene capacitor. The same is true for R4, R12 and R14. These can be replaced with metal film resistors to minimize the noise.
- From the oscilloscope

**Additional Notes:**

- The stereo generator is quite simple in its structure. A square wave which is filtered by a tuned LC filter to a sine wave. The essential is however, the two sine waves phase proportions to each other. This can be adjusted with C3, by experimenting with different capacitances. Then we talk about plus/minus part of a nano-farad! The final result determines the stereo image on a radio receiver.
- It applies to the 4053-circuit it switches the signal equally in both left and right channels. R7, R8 and R9 determines this proportion. Are you not sure, you can match up with an oscilloscope, how much each channel may get.

PROJECT		Stereo transmitter
MODULE		ST-AUDIO
MODEL		36HC108
AUDIT	A-3	DRAIVING: 1 of 1
OTHER		-
B. Lindqvist		2003-04

<b>PROJECT</b>	<i>Stereo transmitter</i>	
<b>MODULE</b>	<i>ST-AUDIO</i>	
<b>MODEL</b>	<b>36HC108</b>	
<b>AUDIT</b>	A-3	<b>DRAVING: 1 of 1</b>
<b>OTHER</b>	-	
<i>B. Lindavist</i>		<i>2003-04</i>

X = Red

II = Green

100mm

**SMR1206:**

R3 = 2k2

R4 = 560k

**SMC1206:**

C1 = 100p

C2 = 33p

Cdc = 10n x 3

**Other components:**

C3 = 47μ, Electrolytic

C4 = 22μ, Tantalum

D1&D2 = Chip diode, Silicon, Switch type

IC4& 5 = 74HC4040, Hole mount

IC6 = 74HC00, Hole mount

Choose between an ordinary or a prec-pot.

**Appropriate crystals for 108 MHz:**

4.5 MHz	Q8 - Q5
9 MHz	Q8 - Q6
18 MHz	Q8 - Q7
36 MHz	Q8 - Q8

*Much of the ST-PLL operation is described in the circuit diagram blade. The design allows you to test and try different processor (CPU) crystals and different resistance values of R1, R2, Rp & P1. The Q- output can be chosen arbitrarily by jumping a output at the 4040- counter to the via marked with an "q". If the crystal that controls the frequency is a lower multiple than the frequency on the VCO, must a correspondingly lower Q- output being selected on the counter. If you choose to divide down the frequency too much, will that punishing themselves with ringing in the audio signal! Jumpers to adapt the adjustment of the frequency with appropriate pot, are marked with different colors. Possibility exists also for parallel connection of resistance over P1 with Rp.*

*The frequency can also be moved forward by connecting one input to the &- gate of IC4's outputs (Q1-Q3). Before you making this - cut the foil at the &- marking.*

**For 107 - 108 MHz:**

CPU crystal = 17.73447 MHz

Q8 - Q7, Green jumper

R1 = 560Ω

P1 = 2k2, Trim pot. with cermets path

R2 = 560Ω

**PROJECT** Stereo transmitter

**MODULE** ST-PLL1

**MODEL** 36HC108

**AUDIT** A-3 **DRAWING:** 1 of 1

**OTHER** -

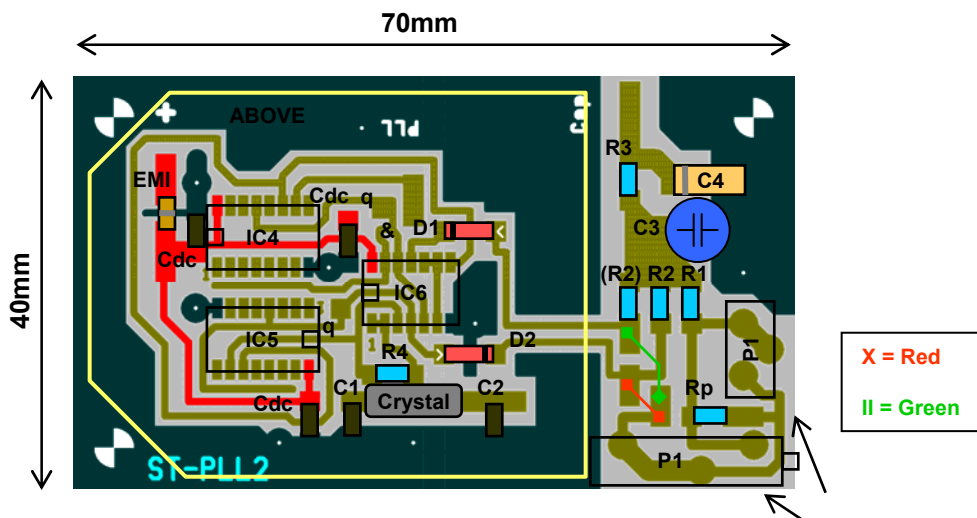
**Double side board. 7 marked holes shall be drilled through and to the ground plane. All components shall be handled as SMD because the ground plane do not have any tracks. The units can be shielded with sheet metal.**

B. Lindqvist

2003-04

<b>PROJECT</b>	<i>Stereo transmitter</i>	
<b>MODULE</b>	<i>ST-PLL1</i>	
<b>MODEL</b>	<b>36HC108</b>	
<b>AUDIT</b>	A-3	<b>DRAWING: 1 of 1</b>
<b>OTHER</b>	-	
<i>B. Lindqvist</i>		<i>2003-04</i>

## PLACING OF COMPONENTS



### SMR1206:

R3 = 2k2

R4 = 560k

### SMC1206:

C1 = 100p

C2 = 33p

Cdc = 10n x 3

### Other components:

C3 = 47 $\mu$ , Electrolytic

C4 = 22 $\mu$ , Tantalum

D1&D2 = Chip diode, Silicon, Switch type

IC4& 5 = 74HC4040, SMD

IC6 = 74HC00, SMD

EMI-filter = 2n2, Usually you not need it

Choose between an ordinary or a prec-pot.

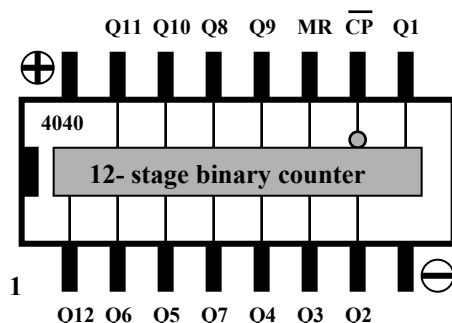
### Appropriate crystals for 108 MHz:

4.5 MHz Q8 - Q5

9 MHz Q8 - Q6

18 MHz Q8 - Q7

36 MHz Q8 - Q8



### For 107 - 108 MHz:

CPU crystal = 17.73447 MHz

Q8 - Q7, Green jumper

R1 = 560 $\Omega$

P1 = 2k2, Trim pot. with cermet path

R2 = 560 $\Omega$

ST PLL2 is the same type of module as ST-PLL1 but with surface-mounted IC's.

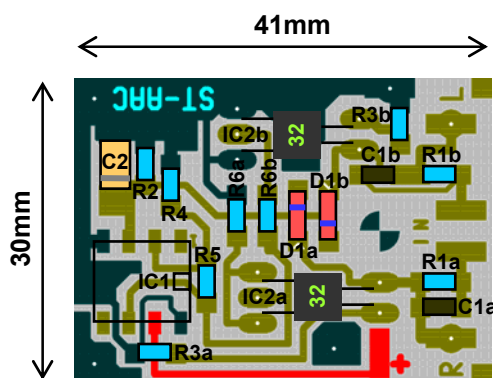
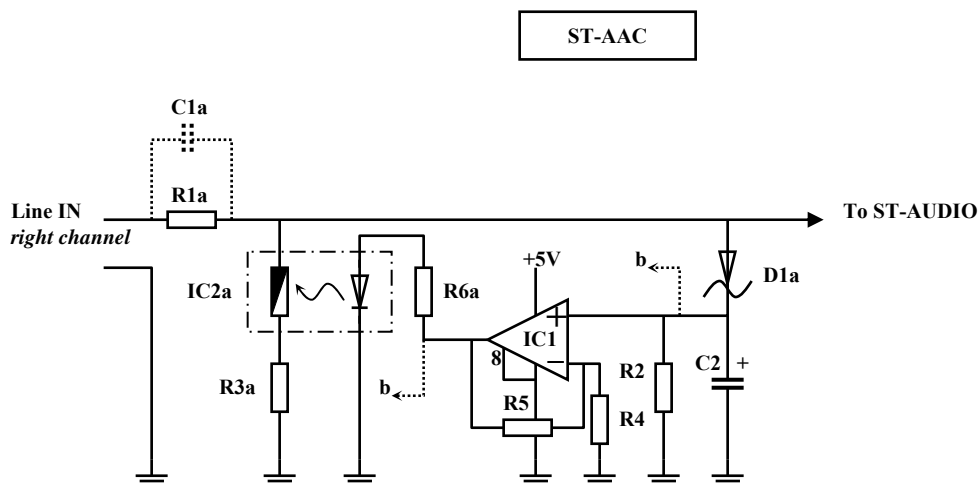
If you wish to experiment with different Q- outputs shall the foil be cut in the q- markings, then you soldering a small line which it attaches to a suitable pin out at the 4040 - counters. If the crystal that controls the frequency is a lower multiple than the frequency on the VCO, must a correspondingly lower Q- output being selected on the counter. If you choose to divide down the frequency too much, will that punishing themselves with ringing in the audio signal! Jumpers to adapt the adjustment of the frequency with appropriate pot, are marked with different colors. Possibility exists also for parallel connection of resistance over P1 with Rp.

The frequency can also be moved forward by connecting one input to the &- gate of IC4's outputs (Q1-Q3). Before you making this - cut the foil at the &- marking. The yellow rectangle shows where the screen housing should be located.

Double side board. 8 marked holes shall be drilled through and to the ground plane. All components shall be handled as SMD because the ground plane do not have any tracks. The units can be shielded with sheet metal.

PROJECT	Stereo transmitter	
MODULE	ST-PLL2	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
OTHER	-	
B. Lindqvist		2003-04

## MODULE PLACING OF COMPONENTS AND CIRCUIT DIAGRAM



### SMR1206:

R1 a&b = 2k2  
R2 = 10M  
R3 a&b = 47Ω  
R4 = 100k  
R5 = 220k  
R6 a&b = 10k

### SMC1206:

C1 a&b = max 10n

### Other components:

C2 = 10μ, Tantalum  
D1 a&b = Chip diode Schottky, BAS85  
IC1 = Operational amplifier TLC271, Hole mount  
IC2 a&b = Optocoupler LDR-LED, NSL-32SR2

Single side board. Three holes can be drilled for ground penetrates also anchor points against ST-AUDIO. All components shall be mounted as SMD. The units do not need to be shielded.

**Automatic Attenuation Control ST-AAC** is a late-developed module that monitors so that the audio signal line output remains at an appropriate level. Various signal sources has different signal strengths. For example, I own some CDs whose output is more than double than what most CD and vinyl discs has as standard ( $\pm 1V$ ), if we now disregard DVD and Blu-ray. If the stereo transmitter is adjusted for a few signal sources with those high recording levels must the modulation be turned down. The consequence is that the SNR increases and thus will the audio quality be deteriorated.

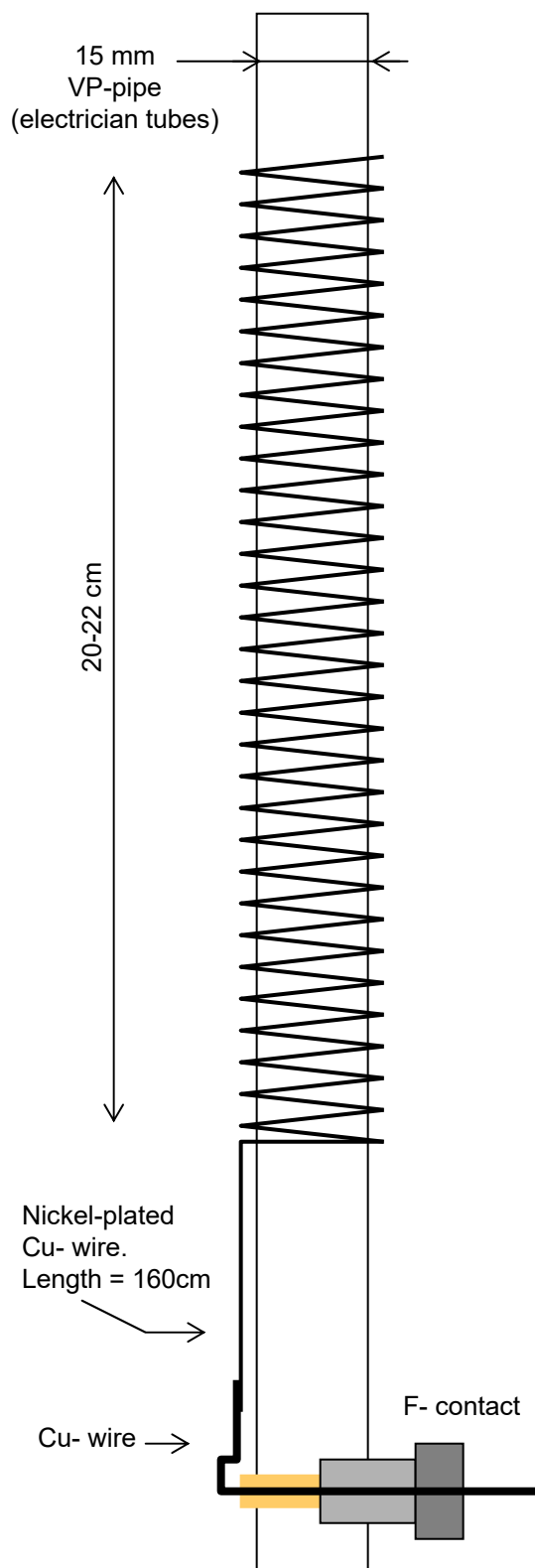
The module cans only attenuating - any amplification is not possible here when the supply voltage is modest 5 volts.

Anyway I think ST-AAC is doing a good job and the modulation can be increased without risking of distortion. All situations can it not handle however, strong and impulsive changes is it not fast enough for and then we get distortion.

**NOTE.** ST-AAC brings a load to the line - more than regular equipment. This precarious attribute actually leads to that the distortion can be eliminated in the entire audio system.

PROJECT	Stereo transmitter	
MODULE	ST-AAC	
MODEL	36HC108	
AUDIT	A-3	DRAWING: 1 of 1
SUPPLY	$\geq 3$ VDC	$< 16$ VDC
CURRENT	$\leq 30$ mA	
OTHER	Can be placed over ST-AUDIO	
B. Lindqvist		2016-02

**DRAWING**



PROJECT	Stereo transmitter	
MODULE	Spiral antenna (recommendable)	
MODEL	36HC108	5/8- GP
AUDIT	A-3	DRAWING: 1 of 1
OTHER	-	
B. Lindqvist		2003-04



## PHOTOS

