23cm FM-repeaterprater

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Self-construction of an accessible FM

transceiver for 23cm. PE1JPD

made a kit for it.

Introduction

The 23cm is a very nice strap. It runs from 1240 to 1300 MHz and this large bandwidth of 60 MHz offers many options, from narrowband EME with JT65 with a bandwidth of a few hertz, to FM-ATV of 20 MHz wide.

There are also ten FM repeaters operational in this band, such as PI6NOS on 1298.375 MHz (Hilversum), PI6HGL on 1298.200 MHz (The Hague) and PI6RTD on 1298.625 MHz (Rotterdam). These are often set up at (very) high locations and have a large reach. The repeaters have a large shift of -28 MHz: the repeater receives around 1270 MHz and transmits around 1298 MHz. It is also possible that the shift is reversed, with the repeater transmitting around 1242 MHz and receiving around 1270 MHz.

Despite the presence of these repeaters, the number of active amateurs is far too low. An important reason is that there is little factory equipment for sale for this tire. To give the activity a boost, I have designed an FM transceiver that can be easily assembled as a kit by an experienced amateur. Years ago I had already designed a data transceiver for high speed packet for the 23cm band. This has been recreated in large numbers at home and abroad. The FM transceiver described in this article is a further development of that concept.

Features of the 23cm transceiver

frequency range:	1240 to 1300 MHz
step size:	25 kHz
modulation:	smalband FM
sensitivity:	-127 dBm (still true-takeable)
budget:	ca. 3 dB
output:	0.5-1 W
shift:	adjustable
CTCSS:	67.5 Hz or higher

The set is available as a kit. Only the speaker, microphone and antenna still need to be connected.

Design

The block diagram of the transceiver is shown in Figure 1 and Figure 2 shows the detailed diagram. The heart van de transceiver is de VCO ALPS1679C (IC7). This is used for both sending and used for receiving. For transmission, it works directly on the transmission frequency of 1240 to 1300 MHz. For receiving, the VCO operates from 1170.7 to 1230.7 MHz taking into account the first center frequency of 69.3 MHz. The VCO is controlled by a PLL (IC8) in phase and frequency locked to a reference frequency of 12 MHz. An all-in chip from Analog Devices is used for the PLL: an ADF4113HV. This IC works up to approximately 4.5 GHz and contains a dual-modulus counter with which a step size of 25 kHz can be set. The 12MHz reference is also used in this IC

divided to 25 kHz, the step size. The HV extension of the IC means that this is the version that can have a control voltage of up to 15 V (instead of only 5 V in the standard version). The reference frequency is generated with a simple 12 MHz crystal oscillator. The stability of this 12MHz signal directly determines the

final frequency: a deviation of 50 Hz at 12 MHz leads to a deviation of 5 kHz (i.e. x100) at 23cm! It is therefore important to make this 12 MHz stable.

The PLL contains a charge pump controlled by a phase and frequency comparator, which supplies a control voltage that is available on pin 2. This control voltage is supplied to the VCO via a loop filter consisting of R13, C39, R14 and C36. Via C35 is added transmit the modulation signal superimposed on this control voltage. For the calculation There are useful tools on the internet to help you determine the resistors and capacitors in the loop filter [1]. I use the calculated values as a starting value for further experiments, since the modulation and especially the sub-audio tone should not be adjusted away by the phase loop.

The signal level from the VCO is 5 dBm, and this is reduced to -5 dBm for the reception mixer IC2 with a 10 dB attenuator. This is an IAM81008, an active mixer with a conversion gain of 8.5 dB.

The antenna signal is first amplified through a MAR-8 (approx. +20 dB) and also goes to the mixer via a band-pass filter for the 23cm band. The mixed product is 69.3 MHz, which goes via a two-circuit bandpass filter at this frequency to IC4, an MC3362. This IC takes care of the entire IF processing.

The first IF of 69.3 MHz was chosen because it was mixed with a standard (computer) crystal oscillator block of 80 MHz (IC3). will be changed to 10.7 MHz. This second IF is filtered in a ke-ramic filter (F1), 50 kHz wide, is then amplified and then mixed with a 10.245MHz signal generated in the oscillator around pin 1-3 of the MC3362. The 455 kHz mixed product is filtered again in a ceramic filter CFU455D (20 kHz) or CFU455E (15 kHz). After further amplification the audio is demodulated

is available on pin 13 of IC4.

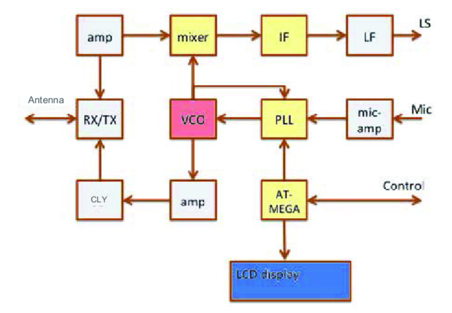

Fig. 1 The block diagram of the transceiver

The MC3362 has a good logarithmic RSSI output which is a measure of the strength of the received signal. This signal is read by the microcontroller with an Analog to Digital Converter (ADC). The mute is built around transistor T2. If the RSSI remains below a set threshold, the microcontroller turns T2 on, shorting the audio to ground. (The microcontroller also activates this mute when transmitting.) The audio is finally amplified to speaker level via the volume potentiometer by an LM386 (IC5). When transmitting, part of the VCO signal (5 dBm) is decoupled via a microstrip coupler (-15 dB) and amplified in a MAR-8 (+20 dB). This makes a signal of +10 dBm available. The reason why a coupler first weakens the coupling and then amplifies it again is that this increases the insulation of the VCO via the transmit amplifier to the antenna. (During reception, this switchable amplifier further weakens the VCO signal that 'leaks' through the transmit amplifier to the input of the receiver, so that it does not block.) The TX signal is then amplified in an AH-1 to 22 dBm (+12 dB) and in T7, a CLY5 FET, again increased by approximately 8 dB to a maximum of about 1 W. The CLY5 requires a negative gate voltage, which is generated by rectification in the FET itself of the offered HF signal. This voltage falls across R46.

The VCO is modulated via the control voltage by a microphone preamplifier around an LM741. A possible (CTCSS) tone is also added to this op amp, which comes from the microcontroller via a low-pass filter. In the current version of the software, a square wave is generated, but the Atmel controller can also generate a sinusoidal signal using PWM (pulse width modulation). Fun to experiment with.

The antenna switch consists of two PIN diodes. When receiving, both of these are blocked, so that the antenna signal is sent directly to the input amplifier is conducted. When transmitting, both diodes are made conductive L5 and R38. The output of the CLY5 is now connected to the antenna via D2, and D1 shorts a quarter wave to ground, transforming this short circuit into a high impedance, with the result that the RX input has actually become 'invisible' from the antenna.

Finally, the RX/TX voltage is switched by transistors T3 to T6. When sending the controller sends T5 into conduction, causing T4 to supply the transmitter amplifier with voltage. In that case, the base of T3 is also high, so that this transistor is off and the receiving side is therefore voltage-free. T6 has been added to speed up switching.

Structure

For the transceiver a through-metal lized print designed. In some ways After the thing lines the top is complete earth plane. The use of extremely small

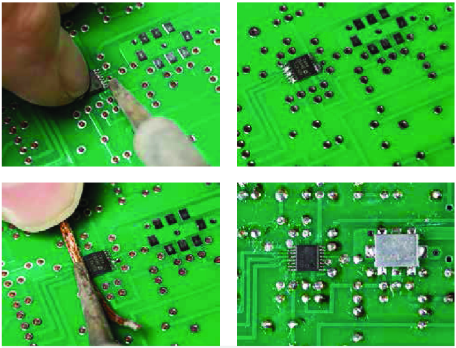

Photo 1a, 1b, 1c and 1d The assembly steps of the phase locked loop circuit. First secure the IC with a pot. If all goes well, solder the rest of the legs. No doubt there is solder running between the connections. Remove this with desoldering wire.

SMD parts have been avoided as much as possible, but the ADF4113HV may be difficult. But this is also quite doable first secure the IC with one leg, and then solder the remaining legs. The position of pin 1 is marked on the PCB. The solder can safely run between the cups, because we then use the soldering wick to suck away all the excess solder. Check with a magnifying glass and a multimeter with a 'beep function' whether there is any closure between the legs. A closure between legs 15 and 16 in particular is disastrous for the IC and leads to fireworks.

The VCO itself is not difficult to install, but the legs are on the side. So place it properly on the pads and solder a leg. If everything seems to be in order, solder the other legs fixed. Of these, there are different in mass and the house.

After the PLL and the VCO, the rest can be done SMD parts are applied. The entrance to MAR-8 is marked with a dot. After the SMD parts, the other parts can be soldered to the top of the PCB. 1

Experimentally it turned out that a resistor of KΩ between pins 21 and 22 of IC4 improves the sensitivity of the IF. This resistance is actually not in the layout. Therefore, solder this to the bottom of the PCB. An additional 1 nF SMD capacitor in parallel with C2 is also recommended, because the transmission loss of the stripline filter thus greatly reduces. Care ensure that the trimmer C48 is installed in such a way that ensure that the screw connection is connected to earth.

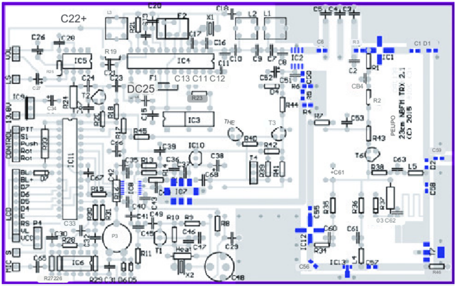

Fig. 3 The PCB layout and the structure of the components

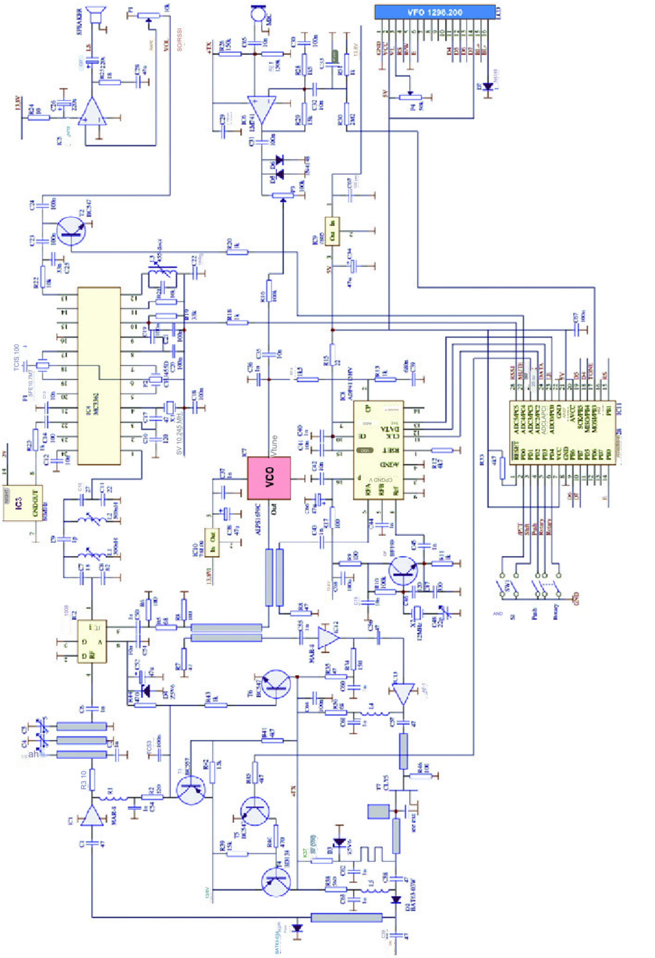

Fig. 2 The diagram of the transceiver

In the diagram, C32 on the PCB has been replaced by a 150 KΩ resistor. This improves the quality of the CTCSS hum.

After building the print, the can is drilled. Choose an orientation for the print in the can and mark the location of the 21 (mini) feedthrough capacitors at a height of 2 cm from the top edge of the can. Drill holes of 2 mm and deburr them with a slightly larger drill. The antenna connection is on the other side of the can. Also mark this on the basis of the print and drill a hole of 2 to 3 mm at a distance of 8 mm from the bottom of the can.

File half a millimeter of the print on the side of the short folded sides of the tin and file the other two corners slightly rounded, so that the print fits properly in the tin. Now solder the PCB at a few points in the tin, at a height of 8 mm from the bottom edge. Make sure you mount this horizontally and keep the can perpendicular by placing it in a lid. Check whether the hole for the antenna coax is in front of the print track. If everything goes well, the print will continue soldering all around; This is essential for proper RF grounding, especially on the antenna side. Finally, press the feed-through capacitors into the drilled holes from the outside with flat-nose pliers and solder them on the inside. The wires of these C's are now soldered to the corresponding islands on the PCB.

Use for the connection to the antenna thin coax; two to three millimeters thick. Tip: tin the outer sheath of the coax and scratch it all around with a sharp knife. You can then break off the outer casing there with a neat result. Remove the inner insulation to within 0.5-1 mm and insert it through the hole in the can so that the outer jacket touches the can. Solder the outer jacket to the tin all around.

Now connect the can to the controls. If the rotary does not work properly or only wants to move in one direction, connect the ground connection to one of the two outer pins.

Test and adjustment

Connect the 13.8V power supply and adjust the contrast potentiometer R4 for optimal image on the display.

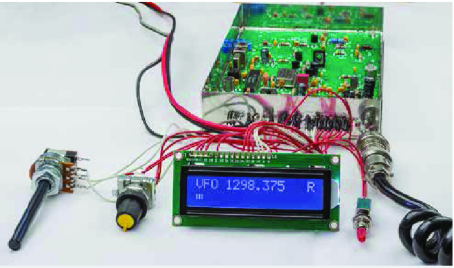

Photo 2 The transceiver in separate parts while a signal of 1298.375 MHz is being received

play. The frequency should then become visible. If not, switch it off and check everything. Please note that the connection for 13.8 V does not make contact with its neighbors, otherwise the microcontroller will immediately die (use shrink tubing!).

First check whether the PLL is in lock. This is possible of course with a frequency counter or spectrum analyzer, but also with a scope or multimeter: when switching from RX to TX and vice versa, the VCO of the PLL makes a jump of 63.9 MHz. This is easily measurable on the control voltage. If the voltage switches back and forth neatly, the PLL is in lock. The frequency can be set precisely with the trimmer C48. The discriminator circuit L3 is generally already set to frequency from the factory; You can possibly adjust this for maximum and symmetrical noise on the scope. The receiving strip is adjusted with the S-meter on the ICD. Preferably start with a signal of 69.3 MHz for the first IF. The entire receiving strip can also be adjusted at once if a reasonably strong 23cm signal is available.

is. Experience shows that the Murata trimmers C3-C5 creak a bit; these must therefore be carefully adjusted, preferably with a plastic or ceramic trim key. make it

possibly make one yourself from a piece of printed circuit board you file it bald and in the right shape. The adjustment of the middle trimmer in particular is quite sharp. When transmitting (PTT to earth), a signal must be audible on a 23cm receiver or scanner at the frequency indicated on the display, provided that the PLL is in lock of course. The frequency can be adjusted with C48. The output without adjustment is approximately 0.5 W at 13.8 V. This can be increased to 700 to 800 mW with an extra C of 0.5 to 1 pF between drain and source of the CLY5. You can also experiment with the stub at the exit

of this FET and/or with the gate resistor R46 (100 Ω - 4.7 KΩ). The greater this resistance, the more negative the gate voltage becomes and the more the FET is pinched off. You can experiment with an noteadjustment pot to find the optimal value. Please with no or too little control, there is no negative gate voltage and the FET draws a lot of current. And you can smell or feel that in the 272 resistance of 1 W. The FET remains intact.

As I already indicated, the stability of the 12MHz oscillator is important. That's why it's on the print space for a small oven on the crystal. You can also solder a PTC of approximately 80 2 to the crystal that is connected to 12 V. But instead of the crystal oscillator you can also install a TCXO. These can be purchased on eBay for a few euros. The frequency does not have to be 12 MHz (expensive!); 12.8 or 13 MHz is also allowed. The dividend for the reference frequency is adjustable in the software.

Finally, if you are close to a mobile phone pole or another strong transmitter, the receiver may be affected. There is no selectivity for the preamplifier as standard. With the antenna connected, the S-meter can already display many bars. In this case, a simple suction circuit at the input of the MAR helps: 15 mm wire in series with a trimmer (5 pF) to ground, mounted under the PCB. Then adjust this trimmer to the minimum deflection due to the malfunction. Or take a ceramic capacitor of 2.7 pF with a total of 15-18 mm connecting wire. Start a little longer and cut the thread a little shorter until the interference is minimal.

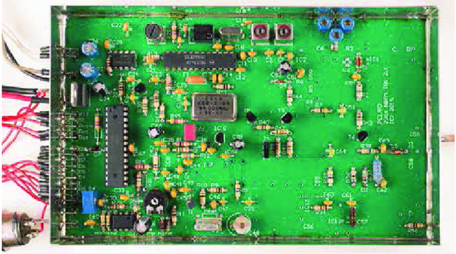
Photo 3 The core of the transceiver

Software

The microcontroller is an Atmel AVR type: ATMEGA328. This chip is also in the well-known Arduinos. The controller controls the various components in the transceiver. reading the rotary encoder for setting the frequency and the menu settings, the PTT and other switches, controlling the ICD with the frequency indication and the S-meter, programming the PLL, and the control of the mute. The controller has an EEPROM on board that allows settings to be saved, even when the power is turned off. This saving always happens after two seconds of inactivity. The controller also generates the CTCSS tone.

The software offers many possibilities for further experimentation, for example connecting an analog S-meter (via pulse width modulation, with which a voltage of 0 to 5 V can be created), or adding memory channels or a scanning function.

The rotary encoder is read out via an interrupt, so that no pulses are lost. The remaining input and display are handled in the main loop of the program.

Use

When the transceiver is switched on, the display shows the current frequency accompanied by a 'T' or 'R' for transmitting and receiving. The second line of the display shows the S-meter as a bar of dashes. If properly adjusted, full scale corresponds to a signal of -65 dBm on the input.

Pressing the rotary tuning knob once will display the menu. Various things can be set in this menu: shift, squelch level and a CTCSS sub-audio tone that some repeaters require. This is disabled at a CTCSS setting below 65.5 Hz. As already indicated, the reference frequency can also be set in the menu.

Construction kit

A professional through-metallized PCB has been designed for this transceiver. The entire transceiver is available as a kit from the author [2] or from the VERON department 't Gooi. Rebuilders are very welcome at our club evenings on Tuesday and Thursday evenings at the VERON in Hilversum for support during construction or to see the end result in a well-equipped workshop.

by measuring. In recent months there have been more than built thirty copies of this transceiver, which has already boosted activity on various repeaters. So mission accomplished!

References

[1] http://www.changpuak.ch/electronics/calc_04.php
[2] https://www.pe1jpd.nl

Radio-amateur noodnet

Electron March 1954

The commemorative edition “Kanaal 3700” was received with great enthusiasm by the amateurs. People hear about it on the amateur bands and at department meetings and there is unanimous agreement that it is valuable that the work of radio amateurs in the relief effort during the disaster days in February 1953 is used in a responsible manner.

written down in a booklet. The official appreciation for “Channel 3700 has also been great and we consider it a great honor.” to have received written proof of this, including from the Prime Minister Dr. W. Drees, the Minister of Transport, Public Works and Water Management Mr. J. Algera, the Director General of the PTT Mr. L. Neher and the Director General of the Rijkswaterstaat Ir. A.G. Maris.

The book has been highly praised in various newspapers discussed.

A true surprise is that the Director General of the PTT announced to the press at the beginning of February that he it deems desirable, after the excellent performances of many (transmitting) amateurs in the disaster days of February 1953, to set up a Radio Amateur Emergency Network in our country, which can be put into operation if necessary in the event of disasters and other calamities. stated. We fully applaud this decision. Contrary to the message that appears in almost every day magazines, PTT did not send a letter to all radio amateurs, but only to a number of them, in which those involved were asked whether they were willing in principle to cooperate in the emergency network in question, and of course on a voluntary basis.

According to these reports, the management of this emergency network has been placed in the hands of the Chief of the Special Radio Service [1]. under the supervision of the chief engineer, Ir. H. Mak. Furthermore, the guidelines, including the procedural

[1] Mr. A. S. M. van Schendel

cost of work, the forms to be used, the frequency at which the emergency network will operate, the contact between management employees regarding test works, etc., will be completed quickly. In the said letter it is considered necessary that simple portable equipment, suitable for battery power, will be available in due course.

This letter is said to have been sent to approximately 100 radio amateurs, effectively spread throughout the country.

Considering the questions that have reached us and the questions that one hears asked on the amateur tapes - because after all, only a few have received such a letter We thought it would be a good idea to bring to your attention all the information we have received here and there.

Your central management has also not yet been informed about this, although this was promised by the Chief of the FRG at the VR meeting of March 29, 1953 in Utrecht, according to the minutes. This is only to show that there is reason for us to be surprised in this respect too. However, we have just now been promised the additional information that will appear for your information. In the meantime, we will work with our sister organizations (IARU) in America and England, where such emergency networks already exist, as well as with the Region I Bureau to determine how these emergency networks work there.

Interest has also been shown from Switzerland. It has become clear from the preliminary data that the PTT itself does not make any equipment available (only batteries in case of disasters, etc.) and therefore only from one administrative guidance can be discussed. This form is appropriate for the government under the given circumstances. indeed the most correct and the least costly because this central leadership can be extremely simple for our small country. Furthermore, full use is made of the manpower and equipment of radio amateurs, who will then form the links of the emergency network.