Gerd Otto, DC 6 HL

A Mini SSB-Transceiver for the 2 m Band

Part 2

4. CONSTRUCTION

4.1. AF/IF Board DC6HL 011

The components can be installed as shown in the component location plan (**Figure 5**) and soldered into place.

It is only necessary for the four mounting holes on the corners of the board, and possibly the ground holes of inductances L52, L53, and L54, to be drilled out.

Thin wires should be soldered directly into the connection points. These wires serve as connection points during the preliminary testing of the boards, and are shortened after installing the board. They are used for the interconnection to the feedthrough capacitors mounted in the screening box. Inductances L51 and L55 must be connected with the aid of a short piece of RG-174 coaxial cable on the lower side of the board in order to connect the oscillator signal to the receive mixer.

A spacer bushing of 4 mm dia. x 4 mm should be

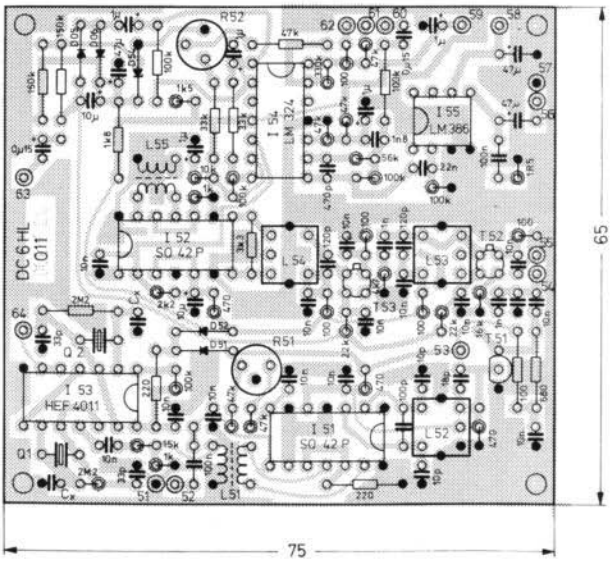


Fig. 5: The AF/IF board DC6HL 011 has through-contacts and its dimensions are 65 mm x 75 mm

soldered to each mounting hole. The PC-board is later fixed into the case using M2 screws placed through these bushings.

4.2. RF-Board DC6HL 010

The component locations on this 60 x 65 mm PC-board are given in **Figure 6**. The same is valid for the holes on this board as was mentioned for the AF/IF-board. It is necessary for the mounting holes for the trimmers C01 and C02 to be drilled out (3 mm dia.). The ready-wound inductances L07, L08, and L10 are inserted so that the cold end of the coil faces towards the board.

It is now possible for all components with the exception of the inductances and capacitors in the screening cans to be mounted into place. Special attention must be paid when mounting the mixer to ensure that it is in the correct position. It should also not be directly touching the board but should have a spacing of 1 mm. All vertical resistors should be mounted in the direction shown in the component location plan, which is, that the shorter connection of the resistor is connected to the "hot" conductor lane. This is followed by soldering the screening panels of the bandpass filter to the upper side of the board. After this, it is possible for the trimmers to be installed. The ground connections should be soldered both to the component and conductor side of the board. The prepared inductances L04 and L05 are placed through the ground and coil tap holes and soldered into position. Finally, it is only necessary for the four fixed capacitors to be soldered into place together with the connection wires. The PC-board is ready for testing after the two wire bridges shown as dashed lines in Figure 6 have been installed.

5. TESTING AND ALIGNMENT

A test and alignment procedure is now to be described that requires a minimum of measuring equipment. Before carrying out an electrical test, it is always advisable to carry out a **careful**, visible check for exchanged components, solder shorts on the conductor lanes, etc.

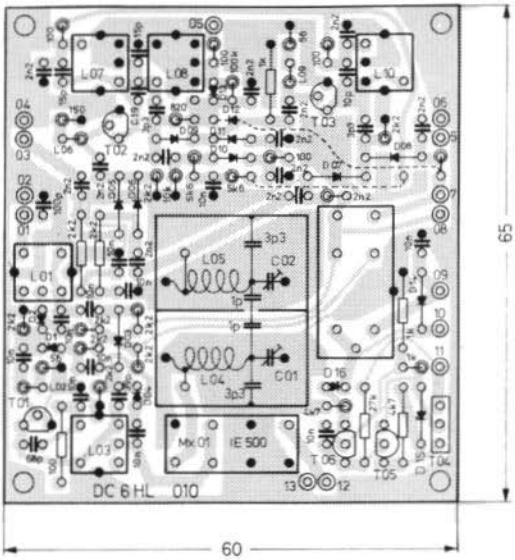


Fig. 6: The RF-board DC6HL 010 also has through-contacts and is 65 x 60 mm

5.1. Preliminary Testing of the AF/IF-Board

a) Connect the board as shown in **Figure 7**.

b) Connect the operating voltage and place the transmit-receive switch to position Tx.

c) Place sideband selector to position LSB.

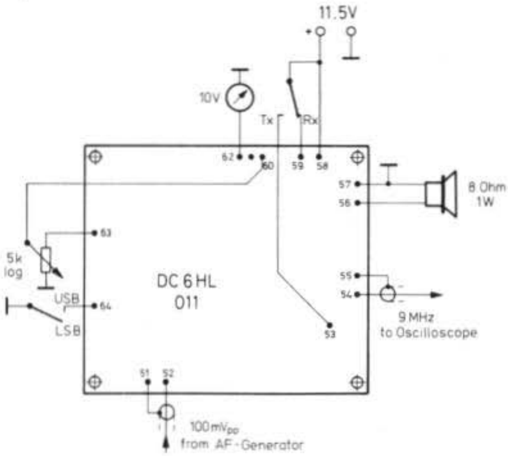


Fig. 7: The operation of the AF/IF board can be checked as shown

Crystal Q2 should commence oscillation. A frequency counter connected to the voltage divider indicates the crystal frequency. Vary C_X of Q2 until 9.0015 MHz is indicated. Switch to USB and align C_X of Q1 until 8.9985 MHz is indicated.

d) Connect a 1 kHz-signal of 100 mV (peak-to-peak) to the microphone input. A modulation envelope should be seen on the oscilloscope connected to the 9 MHz output. This should be aligned for maximum by aligning L 52. If limiting is already occuring, reduce the AF-drive signal.

e) Align the mixer for best balance with the aid of R 51. The envelope should now pass through zero.

f) Place the transmit/receive switch to position Rx, and turn up the volume control until noise can just be heard. Broadcast signals should be heard when placing one's finger or a piece of wire to the 9 MHz input.

g) Without signal, align trimmer R 52 until a voltage of +9 V is present at the output for the PIN-control voltage.

5.2. Preliminary Testing of the RF-Board DC 6 HL 010

a) Connect 12 to 15 V to connection Pt 11. A stabilized voltage of 11 to 11.5 V should now be present at output Pt 10. If this is not the case due to the greater spread of the zener diode D 16, it is possible for the ratio of the two 1 kΩ resistors to be changed somewhat. The current drain should drop to zero on shorting Pt 10.

b) With the PTT-contact open, the operating voltage should be present at $+U_{Rx}$, and at $+U_{Tx}$ when actuated.

5.3. Final Test and Alignment

a) Wire both boards according to **Figure 8**.

b) Switch to receive and set the oscillator signal to 136 MHz. A 145 MHz signal should now be

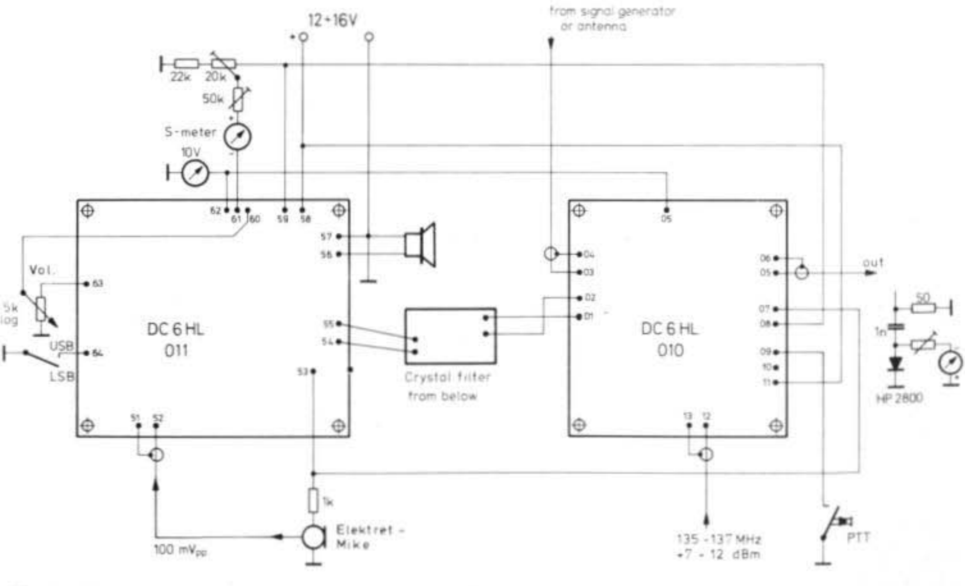


Fig. 8: Wiring diagram of the transceiver; the crystal filter is to be seen in the center. The 10 V-meter shows the testpoint for the stabilized voltage; the circuit for the relative RF-output power indication is seen on the right.

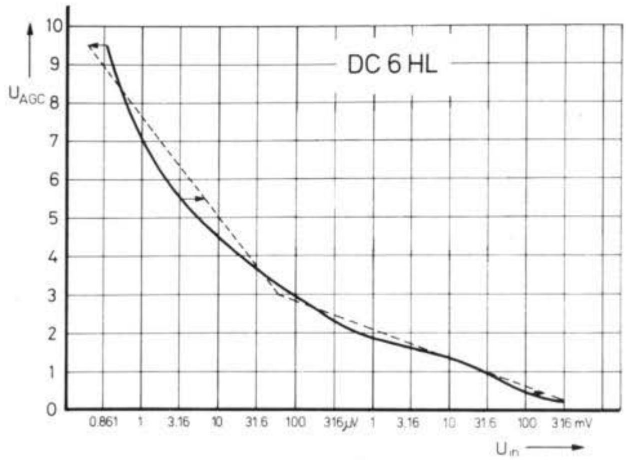


Fig. 9: The control voltage of the PIN-diodes as a function of the RF-input voltage

injected into the RF-Rx input (Pt03), and increased in level until a tone is audible in the loudspeaker.

c) The following should now be aligned to maximum reducing the RF-signal in steps: L54 and L53 on the AF/IF-board, L01 (wide maximum), L03, C01, C02, L10, L08, and L07 on the RF-board. This alignment should be repeated again and again until no further improvement is possible.

d) For alignment of the PIN-control threshold, connect a signal generator with an output of 1 μV to the RF-Rx input (Pt03). Adjust R52 on the AF/IF-board so that a PIN-control voltage of 7 V results. (**Figure 9**). If a signal generator is not available, R52 should be adjusted without signal so that the PIN-control voltage just starts to fall from the maximum value (approx. 9.5 V).

A 100 μA-meter is used as S-meter. A scale as shown in **Figure 10** should be used for this meter. The "zero alignment" is made to the −120 dBm point without signal using the external 20 kΩ trimmer. With an input signal of −70 dBm, the external 50 kΩ trimmer should now be aligned to the −70 dBm point. These two alignment steps should also be repeated several times.

e) Switch to transmit. Feed an input voltage of 100 mV (peak-to-peak) at 1 kHz to the microphone input. A milliwatt-meter connected to the RF-Tx output should now indicate approximately +7 dBm.

If the AF-drive is reduced until the RF-output level is reduced by 3 dB, and the oscillator frequency tuned from 135 to 137 MHz, the level should not drop by more than 1 dB compared with the center frequency. If this is not achieved immediately, one will require a slight correction at C01 and C02, or L07 and L08 on the RF-board.

f) The ripple of the crystal filter can be checked

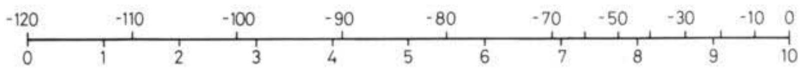


Fig. 10: The scale of a 100 μA-meter can be calibrated as S-meter.

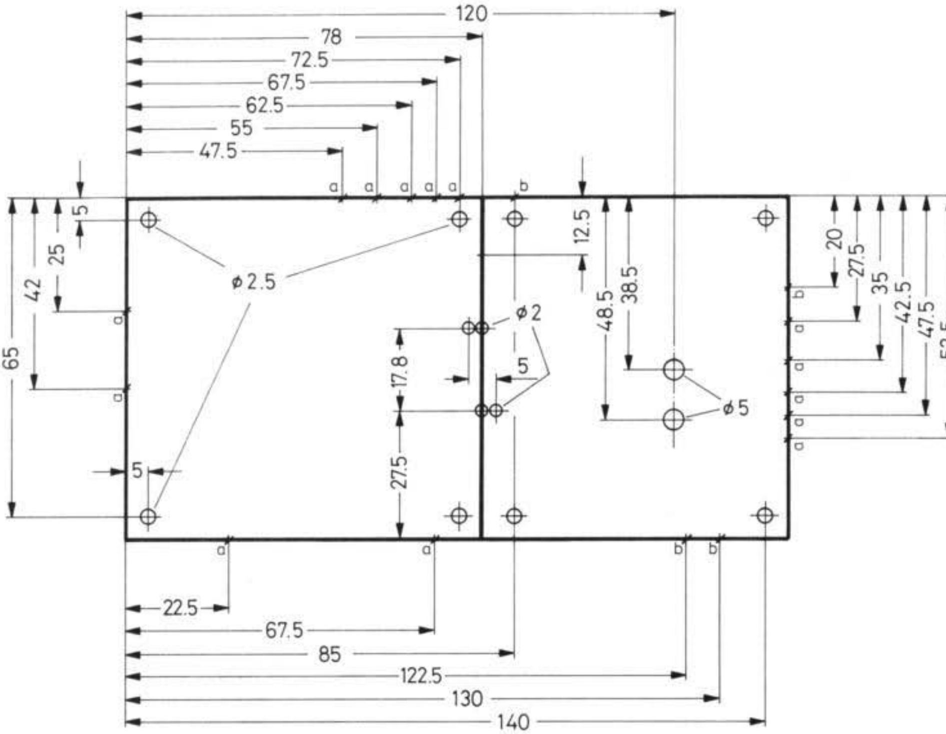
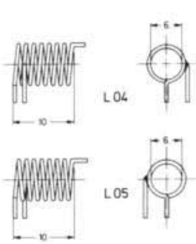


Fig. 11: Required holes in the metal case. A 28 mm high screening panel is placed between the connections of the crystal filter and is also provided with a hole for a feedthrough capacitor approx. 9 mm below the upper edge (as is also the case for the other feedthroughs).

by varying the AF-control frequency. If it is more than 2 dB, the following should be made assuming that no swept-frequency generator is available:
Vary the AF-frequency until a level minimum is obtained. Attempt now to increase the level as much as possible by adjusting L01 (RF-board), or altering the capacitor between Pt01 and Pt02, or between Pt54 and Pt55 (AF/IF-board).
If the ripple is then checked as described above, one will usually have determined an improvement.

g) Short-circuit the microphone input and align R51 for maximum carrier suppression (check with the aid of a 2 m receiver). A carrier suppression of at least 60 dB should be achieved. If this is not possible, exchange I51 or change the ratio between the two 10 pF capacitors. It must then be followed by aligning L52 for maximum.



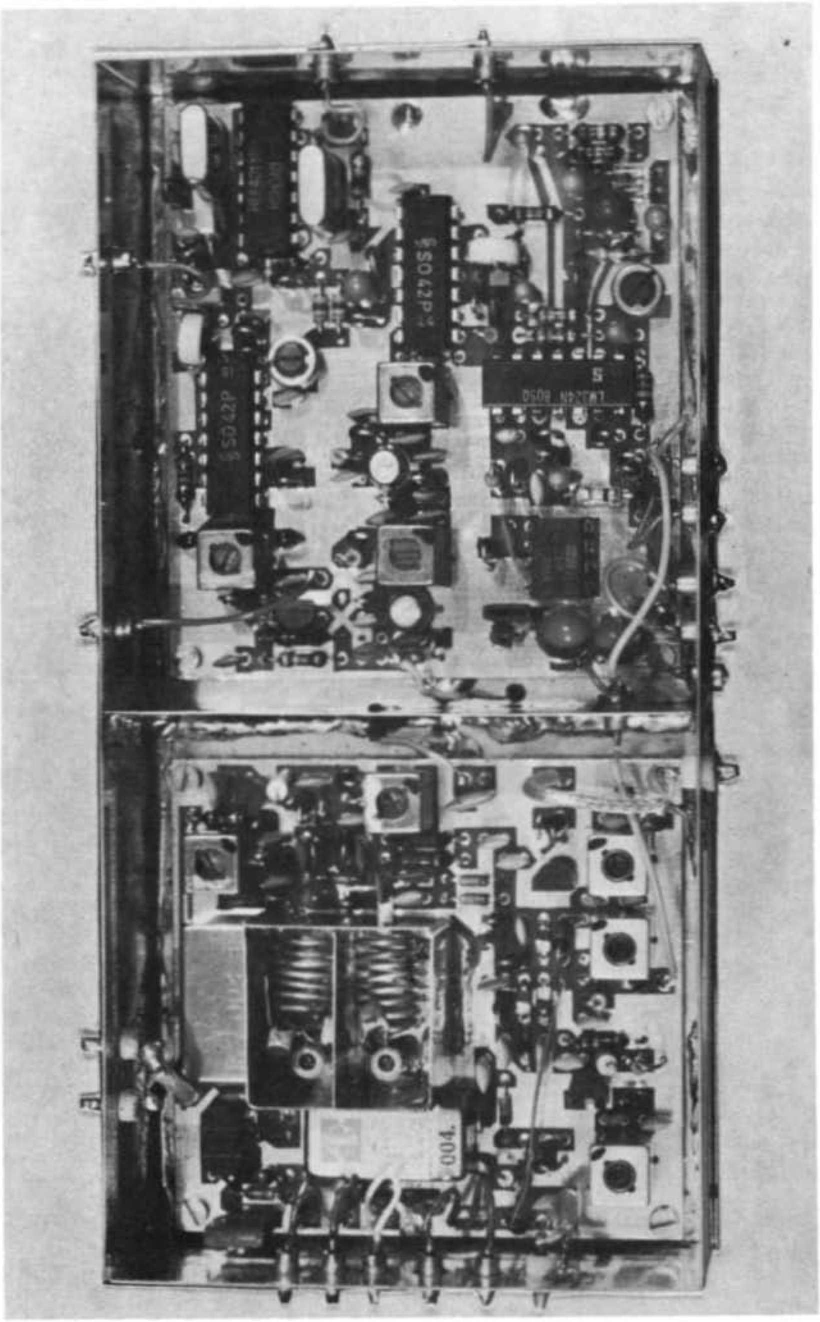


Fig. 12: Photograph of the completed SSB mini-transceiver for 145 MHz

6. INSTALLATION AND CONNECTION

The PC-board module should only be installed into the screening box alfter all the test and alignment work described in 5. has been carried out. The required holes are shown in **Figure 11**. Since the 144 MHz circuits will be slightly detuned, the alignment given in e) of section 5.3. should be repeated after installation.

Figure 12 shows the photograph of the completed transceiver.

7. MEASURED VALUES

The author and DCØZS constructed a prototype from the original PC-boards and kits available from the publishers. The measured values of both prototypes were determined in detail by the author; the resulting values are to be given in the following table. The values of the second prototype are given in parenthesis.

7.1. General Specifications

Minimum unstabilized operating voltage			12.1 V	
Stabilized operating voltage			11.6 V	(11.4 V)
Overall current drain (receive)			90 mA	(82 mA)
Overall current drain (transmit)			97 mA	(90 mA)

7.2. Receiver Specifications

Sensitivity:		RF-voltage for 10 dB (S+N)/N:	0.125 μV	(0.09 μV)
Noise ratio at U_{in} = 1 mV:			51 dB	(48 dB)
Control slope:		Variation of the AF-level on altering the RF-voltage from 1 μV to 100 mV:	6 dB	(4.6 dB)
Image selectivity:		Reference level 1 μV, control fixed, interference signal 127 MHz:	70 dB	(69 dB)
Intermodulation rejection:		$f_1 = f_{in}$ + 100 kHz; U_1 = 10 mV $f_2 = f_{in}$ + 200 kHz; U_2 = 10 mV	64 dB	(62 dB)
		Corresponding intercept point:	+5 dBm	(+4 dBm)
Intermodulation rejection in passband:		$f_1 = f_{in}$ + 1 kHz; U_1 = 10 mV $f_2 = f_{in}$ + 1.4 kHz; U_2 = 10 mV (evaluated with AF-analyzer)	48 dB	(47 dB)
Control time constants:	Level jump:	from −110 dBm to −40 dBm:	1.8 ms	(2 ms)
	Level jump:	from −40 dBm to −110 dBm:	2.5 s	(2 s)
AF-output power for 3% distortion:		(into 8 Ω)	650 mW	(820 mW)

7.3. Measured Values of the Transmitter

Output power	(into 50 Ω)	5 mW	
AF-input voltage	for drive to nominal output power:	100 mV (peak-to-peak)	
Intermodulation rejection:	f_1 = 1 kHz; f_2 = 1.4 kHz $U_1 = U_2$ adjusted so that $P_1 + P_2$ = 1 mW	35 dB	(30 dB)
Spurious rejection	(at full drive to 5 mW): between 135 and 137 MHz: at 9 MHz x 16 = 144 MHz:	 67 dB 74 dB	 (65 dB) (70 dB)
Image rejection	(126–128 MHz):	70 dB	(69 dB)
Carrier suppression	(at full drive to 5 mW):	65 dB	
Harmonic rejection	(at full drive):	32 dB	(31 dB)

This completes the description of the mini-SSB-transceiver. At present, the author is designing a VXO having a pull range of approximately 300 kHz and a spurious rejection of 65 dB, which can be installed in a metal box of 74 x 37 x 30 mm. A 1 W linear amplifier is also being designed. However, the author and the editors request that no technical information is requested until publication.