



Gerd Otto, DC 6 HL

A Mini-SSB-Transceiver for 144 MHz

Part 1

A large number of descriptions have been published for transmit and receive converters for the higher frequency bands 70 cm, 23 cm, and higher. These are usually driven with available (commercial) 10 m or 2 m transceivers. If these transceivers are also to be used for operation on the 2 m or 10 m band, this means that they must be disconnected and reconnected, and how often it is that one wishes to have a separate transceiver for use as driver.

For this reason, the author has designed a small, inexpensive 144 MHz transceiver whose technical specifications are at least equal to, if not much better than the commercial equipment available on the market.

On the transmit side, the output power has been limited to values that are suitable for driving the transverter. This allows the power transistors to be deleted, and thus to construct a very compact unit having dimensions of only 148 mm x 74 mm x 30 mm. According to the application, it can be constructed for a frequency range of 144 to 146 MHz, or 135 to 137 MHz.

1. CONCEPTION AND CONSTRUCTION

Single-conversion with an intermediate frequency of 9 MHz is used for both transmit and receive.

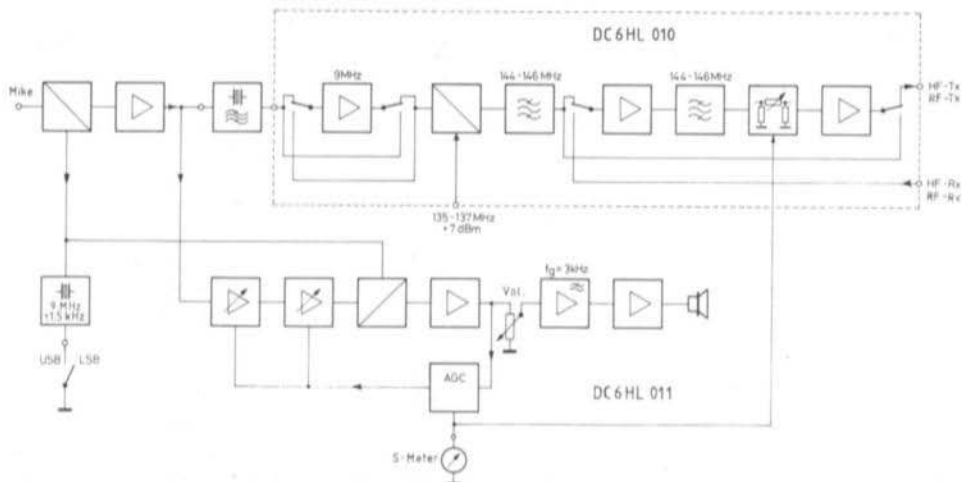


Fig. 1: All components shown outside of the dashed case belong to module DC6HL 011

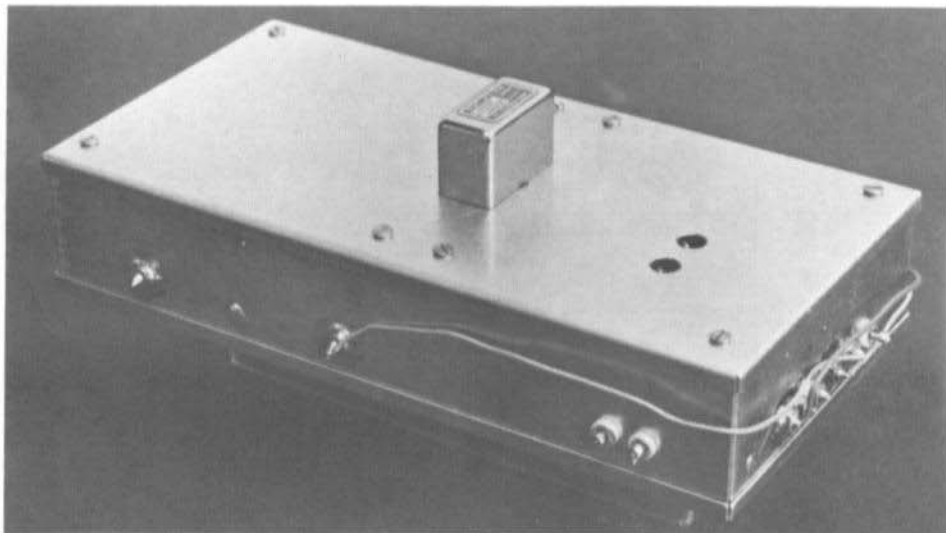


Fig. 2: A complete 2 m transceiver is available if a VXO and a linear amplifier from 5 mW to 0.5 W are added to this module. Suitable modules are to be described in later editions of this magazine.

Expensive and larger components such as crystal filters are used both in the transmit and receive path (see **Figure 1**).

All components are accommodated on a small, double-coated PC-board with through-contacts, and the 9 MHz crystal filter is used to interconnect the AF/IF-board to the RF-board.

In order to achieve ideal electrical conditions, the crystal filter is mounted outside of the metal case, and only its connections protrude into both chambers, in which the PC-boards are accommodated. This allows the high selectivity of the filter to be utilized to the full (see **Figure 2**).

The operating voltage of the miniature transceiver is between 12 V and 16 V. A voltage stabilizer circuit is provided on the RF-board to ensure that the internal operating voltage is maintained at 11.5 V, which can also be used for external accessories.

The transmit/receive switching is made via a PTT-contact which is grounded. The stabilized voltages + U_{TX} and + U_{RX} are also available for external applications.

2. CIRCUIT DESCRIPTION

2.1. AF/IF Board DC 6 HL 011

This part of the circuit is shown in **Figure 3**. All component numbers are higher than 50.

2.1.1. Transmit Path

The AF-signal is fed from the microphone via Pt51 to the input of the integrated mixer I 51, which is built up symmetrically. The drive is made, however, in an unbalanced manner, in order to save using an AF-transformer. For this reason, it is important that inputs 7 and 8 are connected symmetrically, in other words short-circuited for the 9 MHz local oscillator frequency. The RF-signal is injected in a balanced manner (non-grounded). A DSB-signal is available at the push-pull output circuit comprising L 52, whose carrier suppression is excellent, providing that R 51 has been aligned for correct balance. The signal is passed via a buffer (T 51) to the monolithic crystal filter 9M22DI. The termination of the filter is made using the 680 Ω load resistor of the buffer together with the parallel capacitor connected to Pt54.

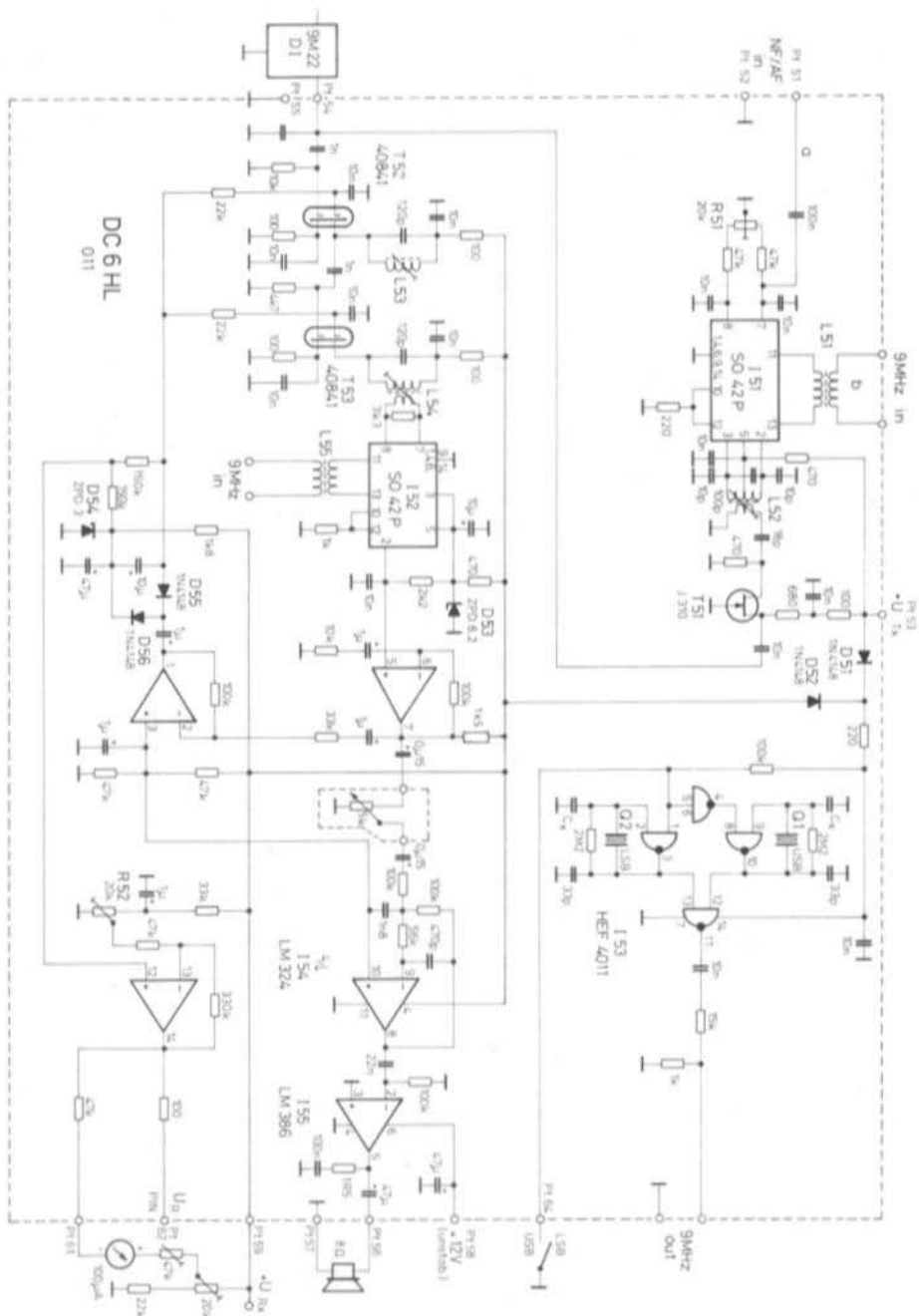


Fig. 3: Circuit diagram of the AF/IF board of the transceiver.

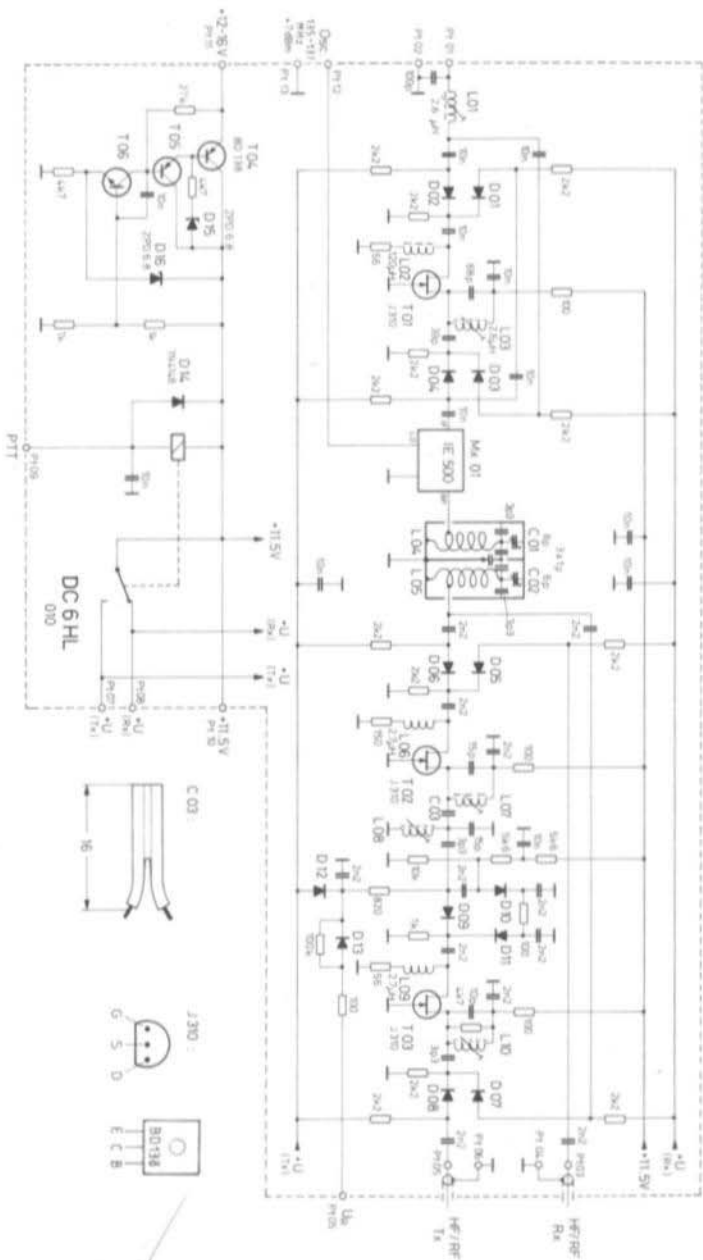


Fig. 4: Circuit diagram of the VHF-module DC6HL 010



2.1.2. Receive Path

After passing through the crystal filter, the IF-signal is passed through the two AGC amplifier stages comprising T 52 and T 53, and is fed via the resonant circuit comprising L 54 to the integrated mixer I 52. The mixer is also provided with the 9 MHz local oscillator frequency via L 55. The demodulated AF-signal is available at the load resistor of 2.2 k Ω , and is subsequently amplified by 11 times in a part of the quadruple operational amplifier I 54. The signal path is separated at the output of this amplifier.

The AF-signal drives an active lowpass filter via a coupling capacitor of 0.15 μ F and the external AF-volume control. This lowpass filter is achieved using a further part of I 54. It is designed for a cutoff frequency of 3 kHz. I 55 supplies sufficient output power for driving a small loudspeaker. The operating voltage for this IC is fed in via Pt58 before stabilizing so that the varying load will not have an effect on the control circuit.

In order to generate the AGC-voltage for the receiver, an AF-voltage is tapped off from I 54/7 and fed to a further amplifier with a gain of three times. This, in turn, drives a voltage doubler rectifier comprising D 55 and D 56. The basic level of this rectifier circuit is maintained at + 3 V using the zener diode D 54. This means that a voltage of + 3 V is present at the anode of D 55 which will be driven towards negative voltages. The control voltage is available directly at the gate 2 connections of T 52 and T 53.

In addition, this voltage is divided by two and drives a further operational amplifier that generates the control voltage for the PIN diodes (Pt62). Its operating point and thus the threshold of the PIN-control can be varied with the aid of trimmer R 52. The amplifier output can also be used for driving an S-meter via connection point Pt 61. The 20 k Ω trimmer potentiometer is used for adjusting the zero point, and the 47 k Ω trimmer is used to set the full-scale value.

2.1.3. Carrier Oscillator

The subcarrier for the upper and lower sideband is generated in a quadruple NAND-gate (I 53).

The required oscillators are actuated by shorting, or opening a ground contact, and their output signals are combined at a further gate.

The squarewave signal of 11 V (peak-to-peak) drives transformers L 51 and L 55 via a voltage divider. In order to generate the operating voltage for the carrier oscillator, diodes D 51 and D 52 combine the transmit and receive voltage so that an additional, continuously available voltage is not required.

2.2. VHF-BOARD DC 6 HL 010

The circuit diagram of this module is shown in **Figure 4**; all component numbers are less than 50.

2.2.1. Transmit Path

The operating voltage + U_{TX} switches diodes D 02, D 04, D 06, and D 08 to conduct. The transformation link comprising 100 pF and L 01 matches the crystal filter to the input of the 9 MHz amplifier equipped with T 01. At the output of the crystal filter, the impedance is transformed to 50 Ω with the aid of the 39 pF coupling capacitor.

The ring mixer Mx01 converts the signal to 144 MHz. The mixer is followed by a two-stage bandpass filter and two amplifier stages with intermediate bandpass filter and PIN-attenuator. The PIN-attenuator is opened in the transmit-mode with the aid of diode D 12.

The signal is passed via a resonant circuit comprising L 10 and connection point Pt 105 and leaves the transmit amplifier at output HF-TX.

2.2.2. Receive Path

The operating voltage + U_{RX} causes diodes D 01, D 03, D 05, and D 07 to conduct so that the VHF-signal from input HF-RX can pass through the two-stage 144 MHz amplifier with PIN-attenuator. This is followed by the bandpass filter comprising L 04 and L 05 and the mixer that converts the signal to 9 MHz. The output of the mixer is terminated by the input impedance of the 9 MHz amplifier.

After the signal has passed through the amplifier, it is fed via D 03 and the transformation link, comprising L 01 and the 100 pF capacitor, to the crystal filter.



2.2.3. Voltage Stabilization and PTT-Switching

Transistors T 04 to T 06 form a voltage stabilizer circuit that is driven with a voltage of + 12 V to + 16 V. The internal operating voltage of + 11.5 V is provided at the output. The circuit can be short-circuited but requires a diode (D 15) to actuate. The operating voltages for transmit and receive are selected by the relay, which is controlled from the PTT-connection.

3. COMPONENTS

T 01 – T 03:	J310 (Siliconix) possibly also BF246	All other capacitors: Ceramic disk types for 2.5 mm spacing.
T 04:	BD 138 (Siemens)	All resistors for 10 mm spacing or smaller, (some resistors are mounted vertically).
T 05:	BC 415 (PNP)	Relay:
T 06:	BC 413 (NPN)	RS-12 V or RHD-12 V (National)
D 01 – D 08:	BA 282, BA 244 (switching diodes)	T 51:
D 09 – D 11:	BA 379 (PIN, Philips)	J310 (Siliconix) or BF 246
D 12 – D 14:	1N 4148, 1N 4151	T 52, T 53:
D 15, D 16:	C6V9 (zener diodes)	40841 or similar DG-MOS FET
Mx01:	IE-500, SRA-1 or better: SRA-1H or even better: SRA-3H	I 51, I 52:
L 01, L 03:	Special coil set, type 5138 (blue/red/white)	S042P (Siemens)
L 02:	120 μ H miniature choke	I 53:
L 04, L 05:	Air-spaced coils from 0.8 mm dia. silver-plated copper wire (see drawing), 7.5 turns on 6 mm former, coil tap: 1.25 turns from the cold end	HEF 4011 (due to speed, no alternative possible)
L 06, L 09:	2.7 μ H miniature choke	I 54:
L 07, L 08, L 10:	Special coil set, type 5118 (silver-plated)	LM324 (National Semiconductor)
C 01, C 02:	Ceramic miniature spindle trimmer 6 pF (Philips)	I 55:
C 03:	16 mm piece of 120 Ohm balanced cable (see Fig. 4)	LM386 (National Semiconductor)
		D 51, D 52:
		1N4148, 1N4151
		D 53:
		C8V2 zener diode
		D 54:
		C3V3 zener diode
		D 55, D 56:
		1N4148, 1N4151
		Crystal filter:
		SSB, with carrier crystals type 9M22DI (Nikko Denshi) or XFM-9B (KVG)
		L 51, L 55:
		2 x 6 turns double-wound, approx. 0.3 mm dia. enamelled copper wire on toroid core R6, 3N30 (Siemens)
		L 52 – L 54:
		Special coil set type 5138 (blue/red/white)
		Ceramic disk capacitors: 2.5 mm spacing
		100 nF capacitors (2 pcs.): 5 mm or 7.5 mm spacing
		Polarized capacitors: Tantalum electrolytics, drop type, 16 V
		2 pcs. trimmer potentiometers 20 kOhm: round types, approx. 6 mm dia.
		15 pcs. feedthrough capacitors for solder mounting, approx. 2.2 nF (value uncritical), short construction;
		4 pcs. PTFE feedthroughs
		1 metal case, 74 x 148 x 30 mm