

PORTABLE SSB TRANSCEIVER FOR 144 - 146 MHz WITH FM ATTACHMENT

PART III: FM ATTACHMENT

by G. Otto, DC 6 HL

7. FM-ATTACHMENT

The SSB transceiver is provided with an independent IF module for the FM mode that is connected just before the SSB crystal filter. Of course, this module is equally suitable for modifying other SSB transceivers for FM reception that have an intermediate frequency of 9 MHz. A small frequency-modulated 9 MHz oscillator is injected after the SSB crystal filter in the transmit mode and replaces the 9 MHz SSB signal. The 9 MHz FM signal is then processed in the transceiver in the conventional manner.

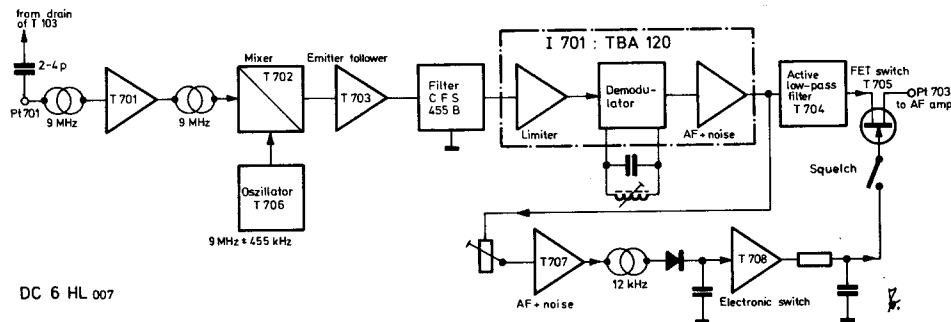


Fig. 28: Block diagram of the FM IF module

7.1. FM IF MODULE

Figure 28 shows the block diagram of the FM IF module. The wideband signal converted down to 9 MHz in the receiver is fed via the tuned amplifier T 701 to the mixer T 702, where it is converted to the second IF of 455 kHz by beating with the local oscillator signal from T 706. The selectivity is gained at 455 kHz using a ceramic filter having a 3 dB bandwidth of 20 kHz (50 kHz at 70 dB). The ceramic filter is followed by a limiter, coincidence demodulator and AF amplifier, which are combined in one integrated circuit (I 701). An active audio filter (T 704) is used to suppress the high-frequency noise components. The module also possesses a squelch circuit which operates as noise amplifier and actuates an electronic switch when no carrier signal is present.

The FM IF module represents a single-conversion superhet tuned to the intermediate frequency of the receiver module (9 MHz). For simplex operation in the transceive mode. It is necessary for the local oscillator frequency to be 9 MHz \pm 455 kHz in order to obtain the required IF of 455 kHz. However, due to the increasing use of repeater stations, it may be required to have a constant transmit-receive frequency spacing of say 600 kHz, which is the most popular spacing at present. This can easily be obtained by shifting the local oscillator frequency from 9 MHz \pm 455 kHz by 600 kHz or the required offset frequency. If a frequency of 9.600 MHz \pm 455 kHz is selected, for instance, this will result in a receive frequency that is 600 kHz higher than the transmit frequency. If the local oscillator is made variable, it is possible for simplex

or any frequency offset to be obtained according to the frequency variation range of the local oscillator. It would, of course, also be possible for a crystal oscillator equipped with two crystals to be used so that one is able to switch from simplex to duplex operation with the required frequency spacing. This FM-IF module only requires an input voltage of 1 μ V which makes it extremely versatile.

The circuit diagram of the FM IF module is given in Figure 29. The input (Pt 701) is loosely coupled via a capacitor of 2 to 4 pF to the drain of mixer transistor T 103 on the main board. Since this coupling is at high impedance, it is not possible for coaxial cable to be used, and the interconnection must be as short as possible. Three ready-wound IF filters as used on the main board DC 6 HL 001 are used in the input stages of the IF module (L 701 - L 703). Ready-wound IF filters are also used in the three 455 kHz stages after the mixer, and for the coincidence demodulator. These miniature IF filters with built-in capacitors save a considerable amount of work during construction. It is only necessary for the inductances for the local oscillator (9.000 \pm 455 kHz or required offset frequency, L 707), and noise amplifier (squelch) (L 708, 12 kHz) to be wound by hand. Since it is important that the resonant frequency of the noise amplifier is exactly 12 kHz, the circuit has been provided with a ceramic capacitor of 10 nF.

Figure 30 gives the PC-board DC 6 HL 007 and shows the component locations; Figure 31 shows a photograph of the authors prototype. The oscillator should be screened; this is not shown in the photograph.

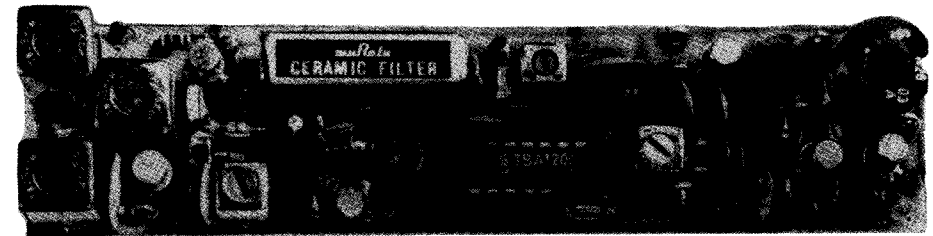


Fig. 31: A photograph of the completed module

7.1.1. SPECIAL COMPONENTS FOR THE FM IF MODULE DC 6 HL 007

I 701: TBA 120 (Siemens)

T 701, T 705: BF 256, BF 245 (TI), W 245 (Siliconix)

T 702 : 40604, 40673 (RCA) or similar dual-gate MOSFET

T 703 : BF 115, BF 224 or similar silicon NPN RF transistor

T 704, T 706, T 707: BC 108 B, 2 N 2926 or similar silicon NPN AF transistor

D 701, D 702: 1 N 4148, 1 N 914 or similar silicon diode

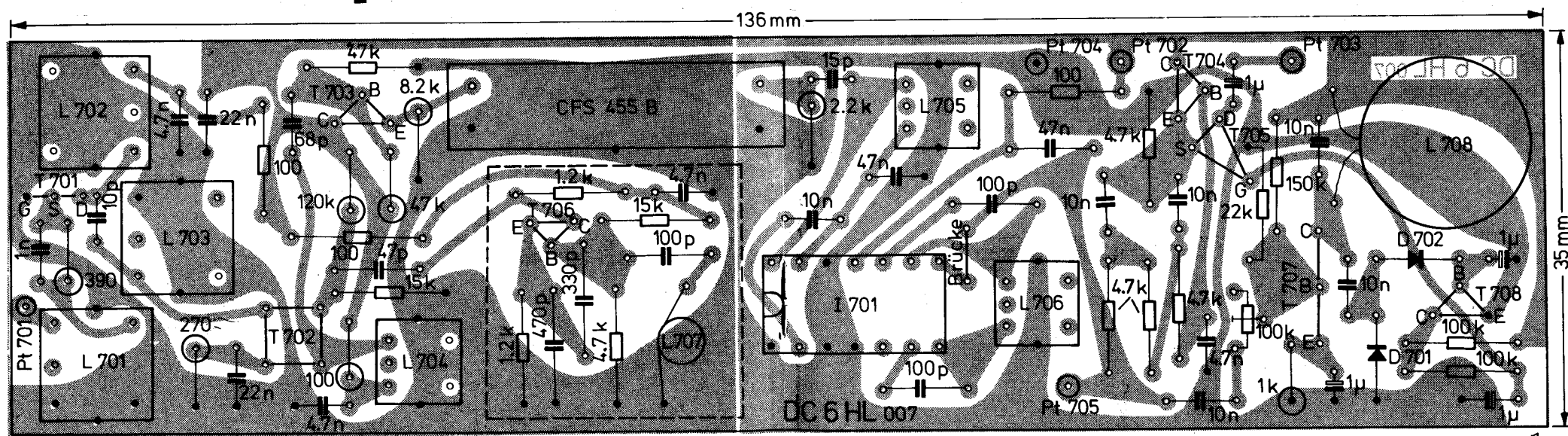
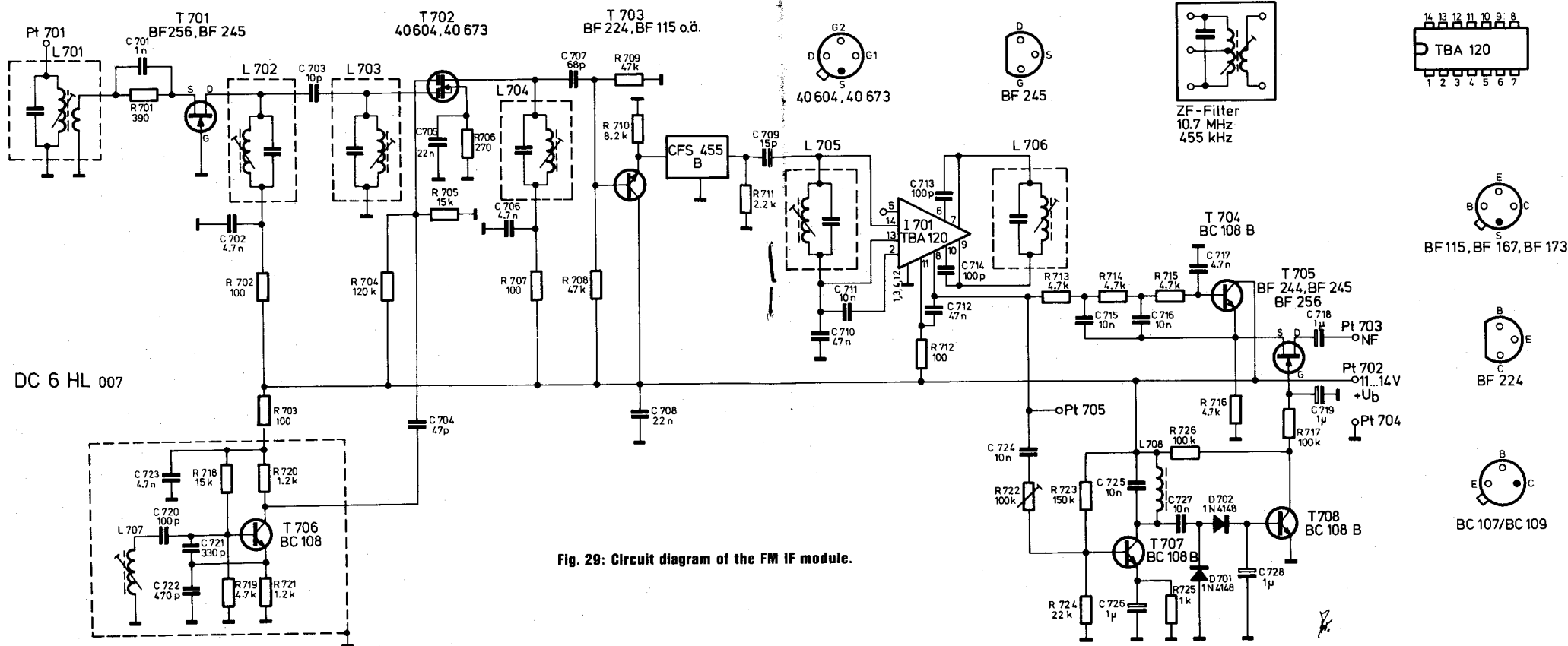
L 701-L 703: 10.7 MHz IF transformers (type FM-FB, with built-in capacitors)

L 704-L 706: 455 kHz IF transformers (with built-in capacitor)

L 707: 14 turns of 0.1 to 0.2 mm dia. (32-38 AWG) enamelled copper wire on a 4 mm dia. coil former with SW core (vary according to offset frequency)

L 708: 18 mH; 268 turns of 0.1 mm dia. (38 AWG) enamelled copper wire in a ferrite potted core. Material N 28, AL-value: 250.

Size 14 x 8 mm (Siemens: B 65 541 - K 0250 - A028)



Styroflex capacitors: 3 x 100 pF; 1 x 330 pF; 1 x 470 pF
 1 miniature trimmer potentiometer 100 k Ω for vertical mounting.
 Spacing 2.5/5 mm.

All electrolytics are tantalum types whose value is not critical.

Bypass capacitors: 1 nF, 10 nF, 22 nF, 47 nF with 5 mm spacings.

7.1.2. ALIGNMENT

Only one special point must be noted with the alignment. The resonant circuit comprising L 706, which effects the phase shift for the coincidence demodulator, should be aligned for best reproduction of a strong FM signal, e.g. for minimum distortion. The signal will be louder and distorted at both sides of the correct alignment. All other stages should be aligned for maximum with a low level input signal which does not cause the IF-module to limit. The centre frequency of strong signals is indicated when the DC voltage at test point Pt 705 falls to half the operating voltage.

The threshold voltage of the squelch circuit can be adjusted with trimmer potentiometer R 722.

7.2. ADDITIONAL FM OSCILLATOR

The output signal of the FM oscillator module DC 6 HL 008 replaces the 9 MHz SSB signal in the FM transmit mode. The circuit diagram of this oscillator is given in Figure 32. The oscillator operates at 9 MHz and is frequency modulated with the aid of a varactor diode. The actual oscillator (T 801) is followed by an emitter-follower, buffer stage (T 802). The output of this module is fed via a capacitance of 10 pF (a trimmer may be used) to the base of transistor T 113 on the main board (DC 6 HL 001). This interconnection is at high impedance which means that it should be as short as possible. However, it can remain connected at all times, which means that it is only necessary to switch the operating voltage of the appropriate module in order to switch from the SSB to FM mode etc.

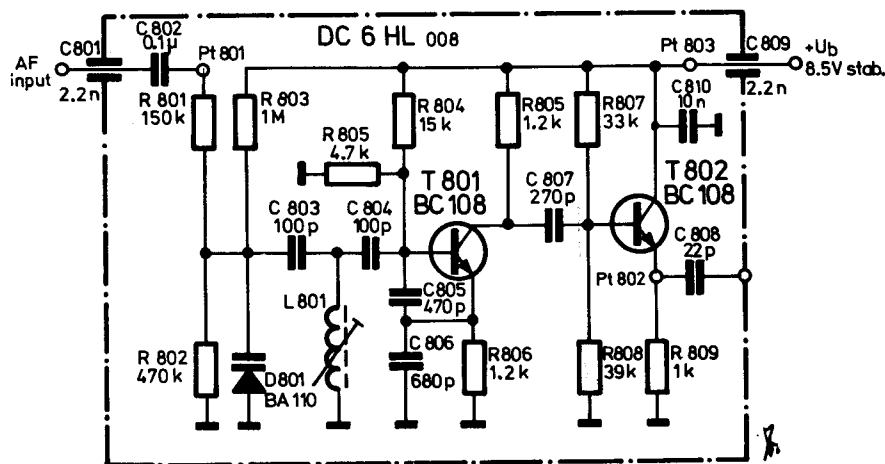


Fig. 32: Circuit diagram of the transmit oscillator

The AF input signal is taken from the emitter of transistor T 111 on the main board DC 6 HL 001 and is fed via a potentiometer for adjustment of the frequency deviation and a isolating capacitor to Pt 801 of the FM oscillator board. The value of this potentiometer is not critical and can be in the range of 1 k Ω to 25 k Ω .

The alignment is extremely simple. It is only necessary for the frequency to be adjusted by aligning the core of inductance L 801 to 9 MHz. The value of the external coupling capacitor (trimmer) to the main board should be reduced to a point just before the output voltage of the transmitter starts to fall.

Figure 33 illustrates PC-board DC 6 HL 008 and shows the component locations. This board is double-coated and the components are directly soldered on to the conductor lanes. No drilling is required. The same principle was also used for modules DC 6 HL 002 and 003. The screening should be fitted with the required two feedthrough capacitors and a low-capacitive feedthrough.

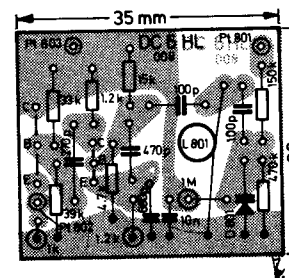


Fig. 33: PC-board DC 6 HL 008 and component plan for the FM transmit oscillator

7.2.1. COMPONENTS FOR DC 6 HL 008

T 801, T 802: BC 108, 2 N 2926 or similar silicon AF transistor

D 801: BA 110 (ITT-Intermetall), BA 121, BA 149 (Tfk) or similar (approx. 10 pF) varactor diode

L 801: 33 turns of 0.35 mm dia. (27 AWG) enamelled copper wire wound on a 5 mm dia. coilformer with SW core.

Styroflex capacitors: 2 x 100 pF; 1 x 270 pF; 1 x 470 pF; 1 x 680 pF.

1 plastic foil capacitor 0.1 μ F.

8. AVAILABLE PARTS

Please see price list.

9. REFERENCES

G. Otto: A Portable SSB Transceiver for 144 MHz - 146 MHz with FM Attachment

Part 1: VHF COMMUNICATIONS 4 (1972), Edition 1, Pages 2-15

Part 2: VHF COMMUNICATIONS 4 (1972), Edition 2, Pages 66-79