PHASE CHECK FOR AUDIO SYSTEMS

While setting up and connecting audio equipment it is important to have all the units — microphone, loudspeakers and everything in between — 'in phase', that is, interconnected with the right polarity. The low-cost instrument described here is particularly handy for checking out the phase of almost any audio system, whether installed in a living room, in a car, in a studio, or on a stage.

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REVERSED phase connections in an audio equipment system give strange and unpredictable effects such as the unwanted attenuation or boosting of a particular frequency range, jet-plane effects, whistling noises, or amplifier output power which does not seem to produce any usable sound level. To avoid these problems, use the simple instrument described here. Based on a transmitter and a receiver with a simple good/fault indication, the instrument will check out the system from the input (microphone or line input) right through to the output (loudspeaker or line output).

The transmitter supplies positive or negative needle pulses, which are fed either electrically to an equipment input, via the line-cinch output socket, or acoustically to a microphone, via the built-in loudspeaker. Accordingly, the receiver has an electrical (line) input and an acoustic (microphone) input.

The drawings in Fig. 1 illustrate two ways of using the transmitter and the receiver for phase tests on audio equipment. Figure 1a shows the set-up used to check the polarity of a microphone, and Fig. 1b that used to ensure a loudspeaker is connected the right way around. The LEDs on the receiver provide a quick indication whether or not the received pulses have the same polar-

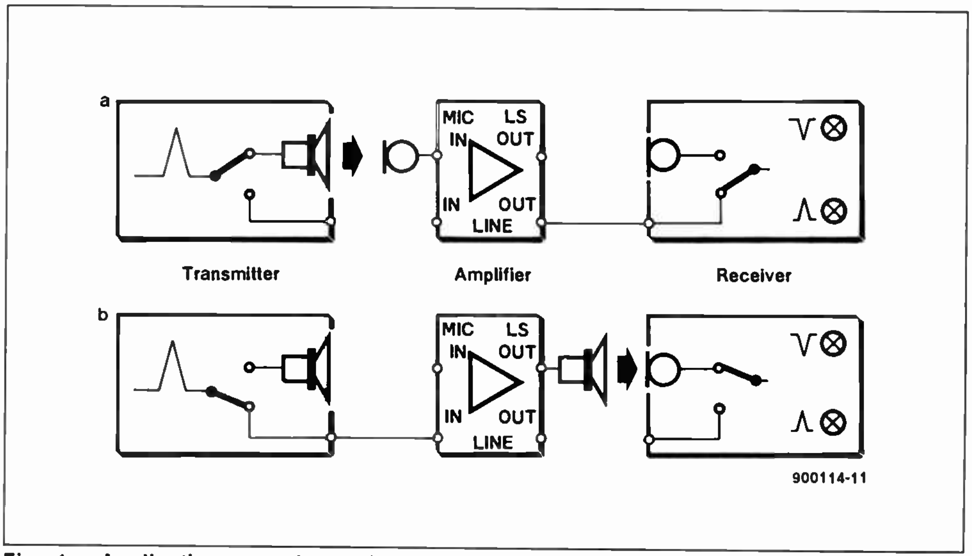

Fig. 1. Application examples of the phase-check system.

ity as the transmitted pulses. If the receiver indicates the opposite polarity of the transmitter, the chances are pretty high that there is a reversed signal connection somewhere in the system.

The pulse transmitter

The needle pulses are generated by oscillator IC1A (see Fig. 2), which is built from a NAND gate with two Schmitt-trigger inputs. After applying the supply voltage, these inputs take on complementary logic levels, i.e., one is high, the other is low. Consequently, the output of the gate is logic high. Capacitor C2 is charged via resistor R1, until the voltage on it reaches the high threshold voltage of about 5.5 V. Next, the output of the Schmitt-trigger toggles to 0, so that C2 is discharged via D1 and R2, until the low threshold voltage of about 3 V is reached. The NAND gate toggles, and the charging of C2 starts again.

The above process is cyclical and results in a self-oscillating circuit. Since R2 is much smaller than R1, the discharge time of C2 is much shorter than the charge time. As a result, the on-off (mark-space) ratio of the output signal is about 2 ms/1 s, or 0.002. Mind you, 'off' means 'logic high' here since we are dealing with a NAND gate.

The oscillator output signal is fed to two sub-circuits. One is a small loudspeaker driver based on emitter follower T2. The loudspeaker connections can be swapped by switch contacts S1C and S1D. When an oscilloscope is connected to the loudspeaker, it indicates negative-going needle pulses with the switch set to the centre position, and positive-going pulses with the switch set to the upper position. Likewise, in the other signal branch, the polarity is changed by switching transistor T1 from a common-emitter circuit (S1B at centre position) to a common-collector circuit (S1B at centre position). Coupling capacitor C3 takes the test signal to an attenuator that supplies output levels of 1 Vpp (0 dBV), –20 dBV and –40 dBV.

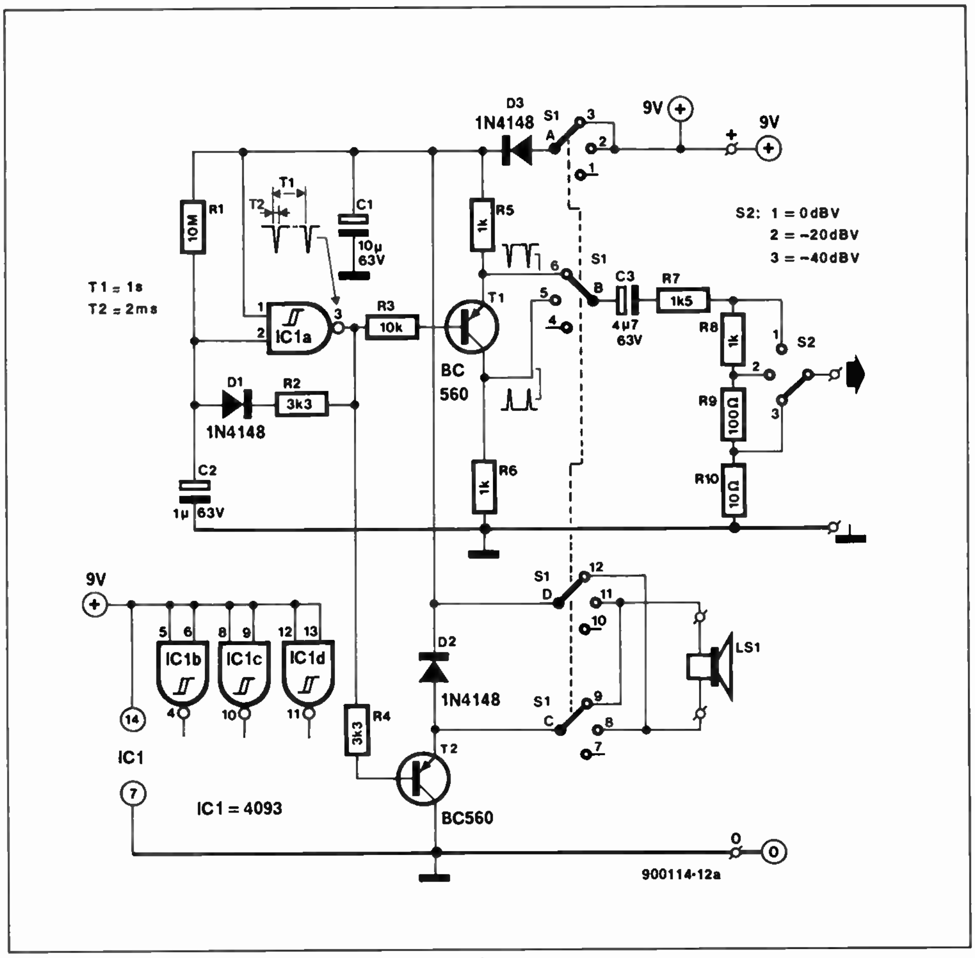

Fig. 2. Circuit diagram of the pulse transmitter.

The receiver

The circuit diagram of the receiver (Fig. 3) shows that two almost identical detectors are used. The test signal is supplied to the two voltage amplifiers T1-T2 and T4-T5 either by the electret microphone, or by the signal source connected to K1. In the latter case, the signal is taken through a high-pass filter, R1-C3, before it arrives at a voltage limiter, D1-D2. The input source, microphone or line, is selected with switch S1. The voltage amplifiers are complementary circuits: T1-T2 amplifies the negative pulses, T4-T5 the positive pulses.

The two monostables in IC1 have different networks at their trigger inputs to enable them to respond to negative pulse edges (IC1A) or positive pulse edges (IC1B). To prevent the trailing edge of a pulse triggering the wrong monostable, IC1A and IC1B disable one another when one of them is actuated. The monostables thus allow the circuit to determine whether a pulse starts with a

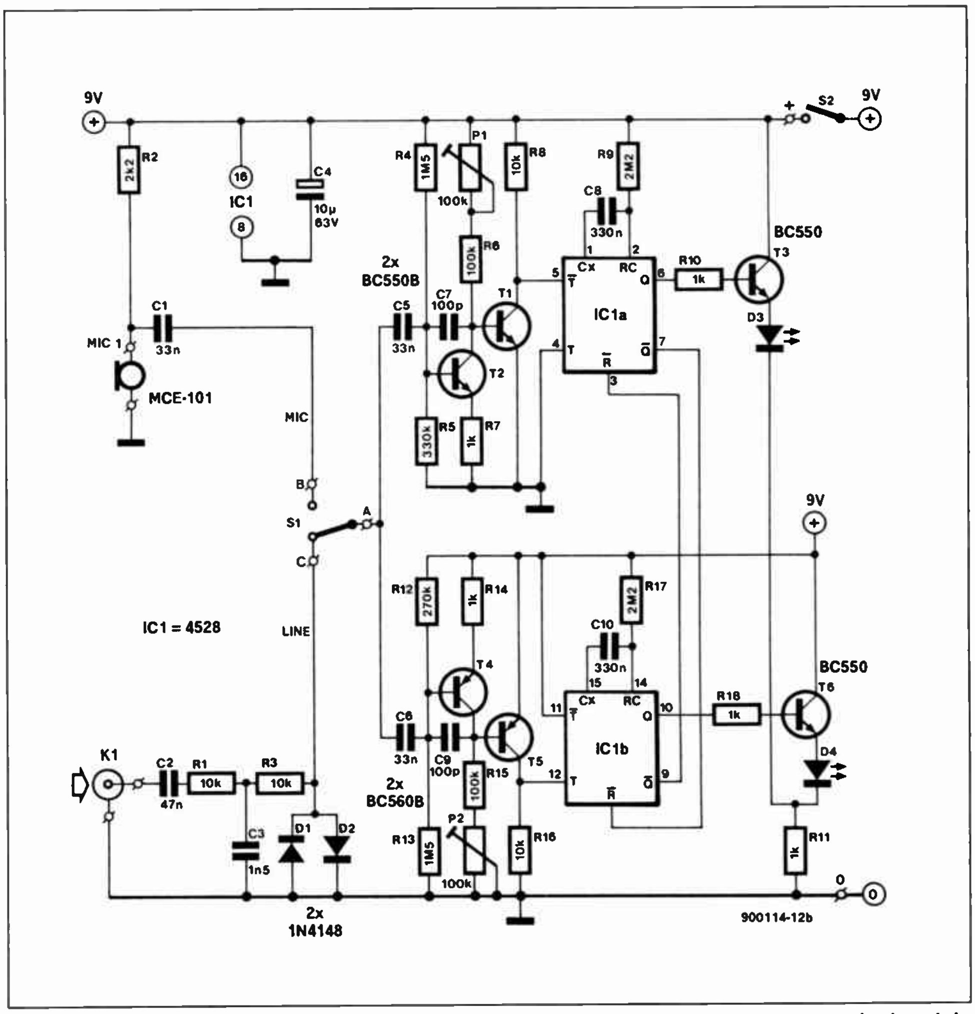

Fig. 3. Circuit diagram of the pulse receiver. The polarity of the measured signal is indicated by two LEDs, D3 and D4.

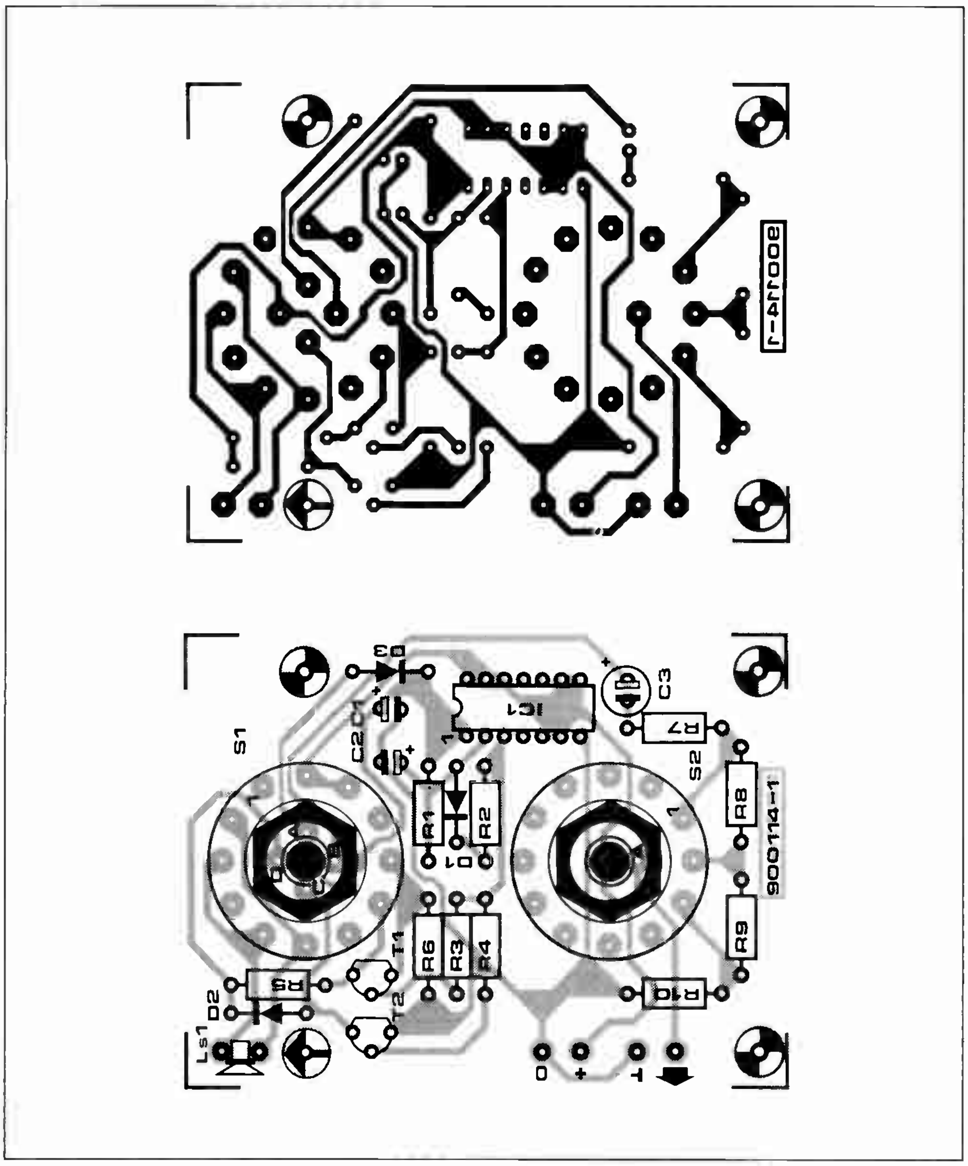

Fig. 4a. Single-sided printed circuit board for the pulse transmitter.

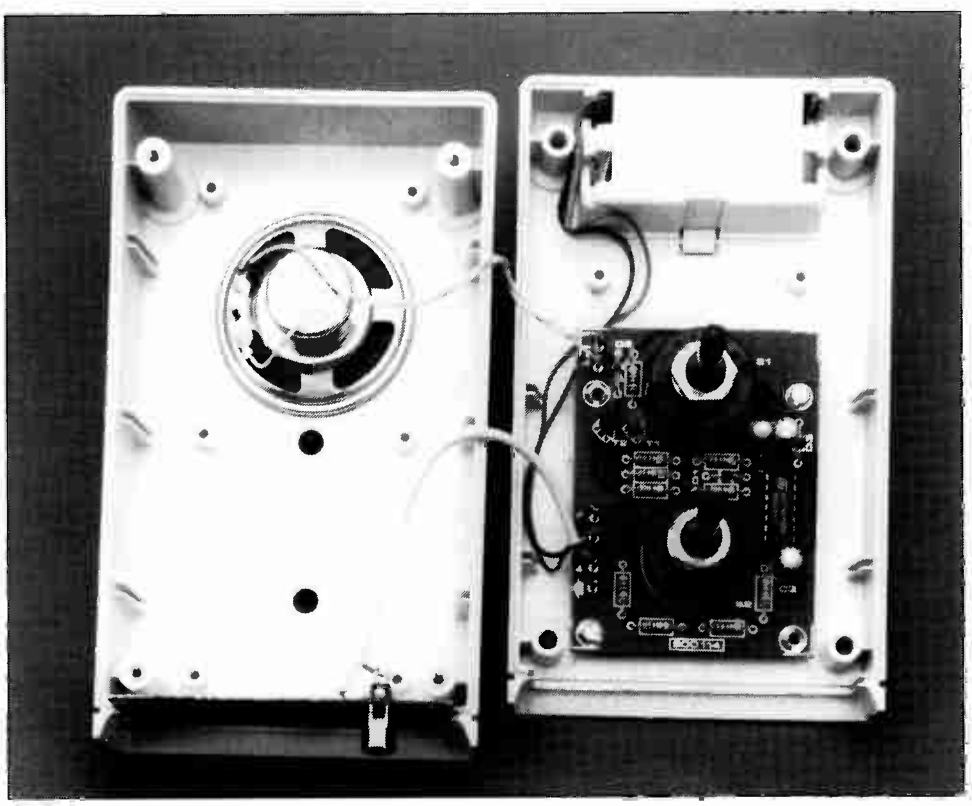

Fig. 5. A look inside the completed pulse transmitter.

COMPONENTS LIST

TRANSMITTER:

Resistors:

1	10MΩ	R1
2	3kΩ3	R2;R4
1	10kΩ	R3
3	1kΩ	R5;R6;R8
1	1kΩ5	R7
1	100Ω	R9
1	10Ω	R10

Capacitors:

1	10μF 63V radial	C1
1	1μF 63V radial	C2
1	4μF7 63V radial	C3

Semiconductors:

3	1N4148	D1;D2;D3
2	BC560	T1;T2
1	4093	IC1

Miscellaneous:

1	3-way 4-pole rotary switch for PCB mounting	S1
1	12-way 1-pole rotary switch for PCB mounting	S2
1	8-Ω loudspeaker, dia. 50 mm	LS1
1	ABS enclosure, e.g., OKW A9409126	
1	clip for 9-V battery	
1	phono socket	
1	printed-circuit board 900114-1	

RECEIVER:

Resistors:

4	10kΩ	R1;R3;R8;R16
1	2kΩ2	R2
2	1MΩ5	R4;R13
1	330kΩ	R5
2	100kΩ	R6;R15
5	1kΩ	R7;R10;R11;R14;R18
2	2MΩ2	R9;R17
1	270kΩ	R12
2	100kΩ preset H	P1;P2

Capacitors:

3	33nF	C1;C5;C6
1	47nF	C2
1	1nF5	C3
1	10μF 63V radial	C4
2	100pF	C7;C9
2	330nF	C8;C10

Semiconductors:

2	1N4148	D1;D2
1	red LED	D3
1	green LED	D4
4	BC550B	T1;T2;T3;T6
2	BC560B	T4;T5
1	4528	IC1

Miscellaneous:

1	electret microphone	Mic1
1	phono socket	K1
1	miniature SPDT switch	S1
1	miniature SPST switch	S2
1	clip for 9V PP3 battery	
1	ABS enclosure, e.g., OKW A9409126	
1	printed-circuit board 900114-2	

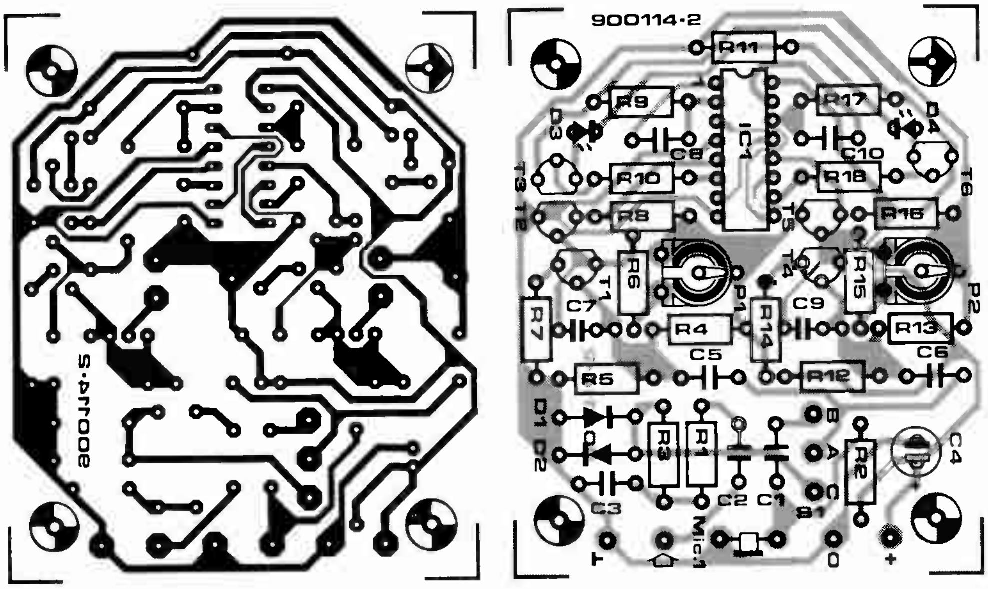

Fig. 4b. Single-sided printed-circuit board for the pulse receiver.

positive (rising) or a negative (falling) edge. The two LEDs, D3 and D4, indicate the respective polarities. The monostable times are set at about 0.5 s with R9-C8 and R17-C10. This causes the active LED to flicker.

Building and testing

The receiver and the transmitter are best built on the printed-circuit boards shown in Fig. 4. Be sure to fit all polarized components (electrolytic capacitors, ICs, transistors and diodes) the right way around. Also make sure that the two rotary switches on the transmitter PCB are fitted as shown on the overlay (note the '1' mark, and the letters that indicate the poles). On completion of the two units, apply the self-adhesive foils shown in Fig. 6 to the enclosure front panels.

Interconnect the transmitter and the receiver via their line sockets, and check that the LED indication on the receiver is in accordance with the polarity set on the transmitter. When the LEDs remain off, IC1 in the receiver may not have sufficient gain. In that case, adjust P1 and P2 until the receiver does trigger correctly. ■

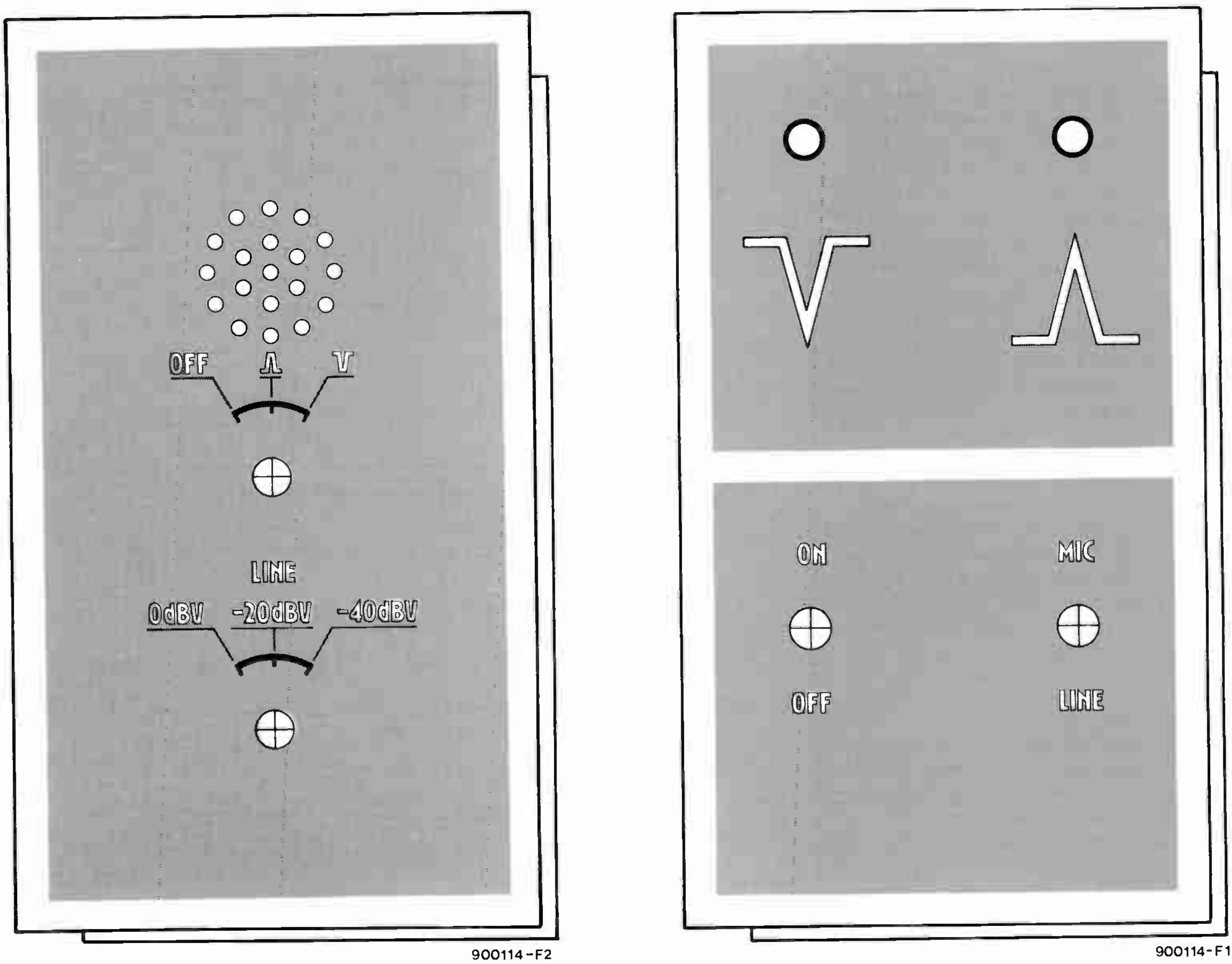

Fig. 6. Design of the self-adhesive front panel foil for the transmitter (left) and the receiver (right).