SPIDER

MANPACK TRANSCEIVER

TYPE 9556 304 14800

PROVISIONAL

FIELD MAINTENANCE MANUAL

HGT5-2542e

OCTOBER 1990

HOLLANDSE SIGNAALAPPARATEN B.V. HENGELO (O) · THE NETHERLANDS

VEHICULAR RADIO SET

Based on the SPIDER Manpack

OPERATORS MANUAL
HGT5 - 2541e

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Associated Manual:
SPIDER MANPACK TRANSCEIVER
Operators manual

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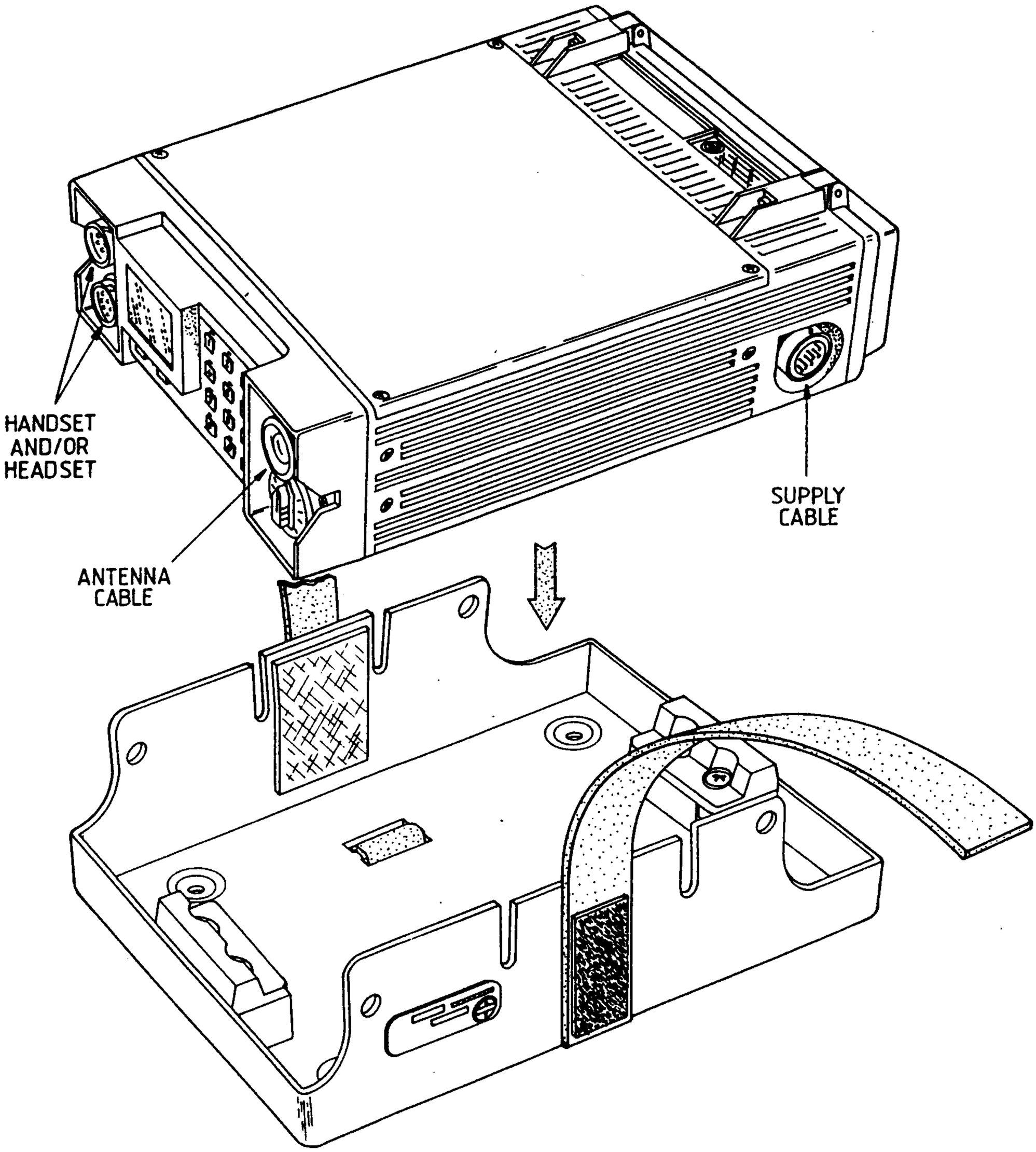
LIST OF ABBREVIATIONS

AC	alternating current
ADC	analog-to-digital converter
AF	audio frequency
AMU	antenna matching unit
DAC	digital-to-analog converter
DC	direct current
EEPROM	electrically erasable programmable read-only memory
EPROM	electrically programmable read-only memory
ESD	electrostatic discharge
IC	integrated circuit
IF	intermediate frequency
I/O	input/output
LED	light emitting diode
LF	low frequency
NTC	negative temperature coefficient
PCB	printed circuit board
PLL	phase locked loop
PSU	power supply unit
PTT	push-to-talk
RAM	random access memory
SPIDER	Signaal Portable Infantry Digital Encrypted Radio
TCXO	temperature compensated crystal oscillator
VCO	voltage controlled oscillator
VHF	very high frequency


HANDSET
AND/OR
HEADSET
ANTENNA
CABLE
SUPPLY
CABLE

CHAPTER 1

GENERAL

1.1 Introduction

This manual provides instructions for field maintenance of the SPIDER manpack radio transceiver.
The SPIDER manpack described in this manual is a portable VHF transmitter-receiver used to provide two-way voice communication in tactical military radio networks.
The battery compartment of the transceiver contains alternatively dry cells or a rechargeable battery block.
In combination with an external power supply unit the transceiver can also be used as a low power vehicular radio set.
An optional Crypto/Data unit may be integrated with the set, providing facilities for high speed data transfer, encryption of the voice or low-speed data, pre-coded messages and selective calling.
This manual, however, refers only to the SPIDER manpack without Crypto/Data unit.

1.2 Technical data

1.2.1 General

Frequency range	: 30.000...107.975 MHz
Channel spacing	: 25 kHz
Number of channels	: 3120
Number of preset channels	: 9
Modulation mode	: frequency modulation
Frequency deviation	: 5 kHz nominal
Speech frequency band	: 300...3400 Hz
Squelch mode	: 150 Hz tone squelch
Supply voltage	: nominal 12V DC (min. 9V DC, max. 16V DC)
Ambient temperature range	
Operating	: -30...+65°C
Storage	: -40...+70°C
Dimensions	: 240 x 175 x 66 mm
Weight	: approx. 2.6 kg (transceiver without accessories) approx. 5 kg (complete manpack)

1.2.2 Receiver

Sensitivity	: 0.4 μV for 10 dB SINAD
AF output	: max. 2V RMS in a 500 ohms load
Image rejection	: 60 dB or better
Selectivity	: 60 dB or more suppression of a signal ± 25 kHz from the receiver frequency
Current consumption	: approx. 140 mA

1.2.3 Transmitter

RF output power	: four user selectable levels 20 mW (7...19 dBm) 200 mW (20...28 dBm) 2 W (31...35 dBm) 5 W (34...39 dBm)
Output impedance	: 50 ohms
Max. standing wave ratio	: 4:1
Harmonic suppression	: 50 dB or better (60 ... 400 MHz)
Current consumption	: approx. 1.2A for 2W output power approx. 2A for 5W output power

1.2.4 Interfaces

The SPIDER manpack provides interface connecting points as listed below for the following connectors:

a. Antenna connector.
b. Audio 6-pole connector.
c. Audio 10-pole connector.
d. Supply/Peripheral connector.

The connector points may be used for signal transfer, control, selection and supply.

a. Antenna connector

50 Ohms coax = Antenna in/output for the radio frequency range 30 - 108 MHz

b. Audio 6-pole connector

A = Common ground
B = Telephone output: max. 2V RMS in 500 Ohms
C = Transmit contact (PTT input).
D = Microphone input: - whisper 0.5 - 50 mV RMS
- normal 2 - 200 mV RMS
- retransmission 500 mV RMS
E = Squelch contact (open collector output).

F = Channel preset selection: an external connected resistor (e.g. in the hand-set) may define the preset channel to be selected:
- 470 kOhms (2%) = channel 1
- 180 kOhms = channel 2
- 100 kOhms = channel 3
- 68 kOhms = channel 4
- 47 kOhms = channel 5
- 33 kOhms = channel 6
- 22 kOhms = channel 7
- 15 kOhms = channel 8
- no resistor (open) = channel selection via keyboard.

c. Audio 10-pole connector *)

A = Common ground.
B = Telephone output (see b.)
C = Transmit contact.
D = Microphone input (see b.).
E = Squelch contact.
F = "NOGO" information (active low).
G = not used.
H = Peripheral address: an external (built-in) resistor may define the address as implemented for the peripheral equipment to be connected:
- 470 kOhms (2%) = Retransmission cable.
- 180 kOhms = Message Exchange Device.
- 68 kOhms = Intercom system.
- 33 kOhms = Fill gun device.
- no resistor (open) = Hand- or head-set.

J = +12 Volt supply to be used for peripheral equipment.
K = "Data mode" information (active low).

*) The V24/28 data-interface is provided when the Crypto/Data unit is available and the data mode is selected.

d. Supply/Peripheral connector

A = External supply ground
B = External supply input (+10...15 Volt)
— Internally connected if external supply is present with the correct polarity.

C = Battery recharge current input (max. 100 mA).
D = Data signal ground
E = Data signal output
F = Data signal input
— Data interface (V24/28, 2400 Bd) for control of peripheral equipment.

G = +5 Volt supply for peripheral use.

H = Peripheral address, to be defined by an external resistor included in the peripheral connection.
- 47 kOhm (2%) = Remote control.
- 6.8 kOhms = External equipment.
- 2.2 kOhms = Test equipment.
- no resistor (open) = Supply cable.

J = Common ground.

1.2.5 Power supply

Internal *)	: 10 batteries type R14, Nicad (rechargeable) or Alkaline (to be replaced).
External	: 10...15V DC, max. 2A to be supplied via the rear connector.

*) Re-charge facility by connecting a battery charger via the rear connector, the battery charge current should be max. 100 mA.

1.3 Component parts

The SPIDER manpack transceiver is composed of the following parts.

Unit	Signaal Code nr.
Transceiver	9556 304 14800
Carrying harness	9556 304 20600
Antenna matching unit	9556 304 20400
Antenna (long)	9556 004 14100
Handset	9556 004 08200
Rechargeable battery block	9556 304 20700
Instruction card	HGT5-2528e

Optionals	Signaal Code nr.
Battery holder for 10 dry cells	9556 304 20300
Handset with channel selector switch	9556 004 08300
Headset	9556 304 27400
Retransmission cable	9556 820 60000
Antenna (short)	3522 023 17370

Replaceable printed circuit boards	Signaal Code nr.
Transmitter - receiver PCB	9556 820 27500
Exciter - Power supply PCB	9556 820 27600
LF - control PCB	9556 820 27700
Reference circuit PCB	9556 820 33100
Front panel PCB	9556 820 27400

1.4 Differences among models

No different versions of the SPIDER manpack described in this manual exist. The SPIDER manpack with an integrated Data/Crypto unit is described in a separate manual.

CHAPTER 2

TECHNICAL DESCRIPTION

2.1 General

This chapter contains a concise technical description of the transceiver, using block diagrams of the electronic circuits. An explanation of the symbols used in the block diagrams is given in diagram 1. The block diagrams consist of one overall block diagram of the entire transceiver, plus one block diagram for each of the PCB's used in the transceiver. Some information concerning the mechanical construction of the transceiver is also given in this chapter.

2.2 Description of the overall block diagram (see diagram 2)

On the block diagram the basic functions are given for the transfer of voice signals and the control of the transceiver.
The signal path shown on the diagram illustrates the normal operational mode: receiving in FM voice mode.
The description is given for the following functions:

a. Audio Input/Output circuit.
b. Frequency Synthesizer and Modulator.
c. Receiver and Demodulator.
d. Transmitter.
e. Processor control.
f. Supply regulator.

a. Audio Input/Output circuit

The Audio Input/Output circuit provides the interface for the audio connectors (6-pole and 10-pole).
Amplifiers and buffers will bring the audio in/output signals to the required level as set by the volume control.
The Audio Input circuit will limit the AF signal used for modulation of the transmitter.

A 750 Hz audio signal is provided for alarm indications or warnings to the audio interface.

The audio in/output signals are transferred to/from the Modulator/Demodulator circuits.

b. Frequency Synthesizer and Modulator

The radio frequency on which the transceiver is operating is defined by the preset channel selection or the entry of a frequency value via

the keyboard. The required frequency signals are generated in the Frequency Synthesizer, using PLL techniques and a reference oscillator.
The Frequency Synthesizer is programmed for the selected carrier frequency by means of the processor control (Ch./Freq. Select).

The Modulator provides frequency modulation with the signal from the Audio Input circuit (FM voice mode). In FM voice mode a 150 Hz squelch tone is added to the modulating signal.
The modulated carrier signal is passed-on to the Transmitter via the RF Preselect filter.

c. Receiver and Demodulator.

The aerial input signal comes in via the RF Preselect filter which is used for either transmit or receive.
A frequency signal being programmed from the Frequency Synthesizer will select the required channel for the Receiver.
For demodulation an FM discriminator is used to obtain the signal from the received channel, with or without detection for tone squelch.
When the squelch facility is enabled (Squelch ON) the detected 150 Hz tone will activate the squelch contact for the audio connection. The received signal is passed-on to the Audio Output circuit.

d. Transmitter

The Transmitter will provide the antenna output signal when the transmit-contact (PTT) from the audio interface is activated.

The power level can be set in three steps.
For adverse conditions an extra high level may be set via a specific key (Burn-through).

Transmission will be inhibited by the processor control on the moment a new channel/frequency is selected or when a system failure occurs.

e. Processor control

The processor control in the transceiver system is performed by the Processor & Memory.
Functions for control are provided by the keyboard and display.
Besides control, the status of various functions is obtained to monitor the system functioning.
A built-in test facility (BITE) provides the "go/nogo" information for the processor.
Furthermore information may be obtained from the interfaces about the type of equipment being connected or the preset facility built-in.

Information about system status is provided for the audio interface.

The memory contains the required processor software and provides the storage of preset data for the various channels.
The preset data are stored in a non-volatile memory.

f. Supply regulator

When switched-on the Supply regulator provides the voltages for supply of the transceiver circuits, to be taken from the internal battery supply or an external connected supply. Supply is also provided to the interface connections for peripheral equipment.
When Nicad batteries are employed re-charging is possible via the Supply/Peripheral connector. This connector includes also the interface for peripheral control.

2.3 Transmitter - receiver circuit board
(see diagram 3)

Diagram 3 shows the block diagram of the transmitter - receiver PCB. The signal path is shown in solid lines, the control signals in dotted lines. The numbers between brackets (.) in the text refer to the numbers in the block diagram. The transmit - receive relays are shown in the receive position.
When receiving the antenna signal is connected via transmit - receive relays (1) and (2) to bandswitch (3). Bandfilters (4) and (6), separated by RF amplifier (5), are used to obtain the necessary suppression of image frequencies and other out-of-band signals. Because of the wide frequency range three sets of filters are used. The filters are electronically tuned by means of a DC voltage supplied by the control circuit (18).
Via bandswitch (7) and transmit - receive switch (8) the receiver signal is connected to the first mixer (9). Here it is mixed with the local oscillator signal, supplied by the exciter PCB, to obtain the first IF of 11.5 MHz. Crystal filter (11) is used to obtain the required selectivity. Buffer amplifiers (10) and (12) supply some amplification, but are also used to obtain the correct impedance for mixer and filter.
In second mixer (13) the receiver signal is mixed with an 11.1 MHz local oscillator signal, supplied by the exciter PCB, to obtain the second IF of 400 kHz. The bulk of the amplification is supplied by amplifier /limiter (14). Also information about the signal strength is send via buffer amplifier (17) to the control PCB. This information is necessary to obtain the correct tuning voltage for the filters (4) and (6).

Demodulation of the FM signal is done by detector (15). The AF signal is connected via buffer amplifier (16) to the LF-control PCB.

When transmitting, the transmitter signal, supplied by the exciter PCB, is connected via relay (2) to the receiver input circuit. The filter-amplifier circuit (3), (4), (5), (6) and (7) is now used for filtering the transmitter signal. The filtered signal is connected via switch (8) to the transmitter power amplifier (19). Here the signal is amplified to the desired power level (approx. 20 mW, 200 mW, 2W or 5W), as selected by the operator via the keyboard and the control circuits. To suppress the harmonics generated by the power amplifier, three low-pass filters (21) are used, selected via band-switches (20) and (22). Via relay (1) the transmitter signal is connected to the antenna.

To obtain the correct tuning voltage for filters (4) and (6) the following method is used. After switching on or selecting a new channel first the transmitter oscillator and the receiver oscillator are tuned to the correct frequency. The transmitter signal is connected to the receiver input via relay (2). Now the tuning voltage is swept through its range. The signal strength is monitored by the control circuit via analog-to-digital convertor (23) and it is noted which tuning voltage corresponds to maximum signal strength. This information is send in digital form via the data bus to control circuit (18). Here digital-to-analog converter (24) is used to generate the correct tuning voltage. This tuning voltage remains constant for as long as the selected frequency remains the same.

2.4 Exciter - Power supply circuit board
(see diagram 4)

Diagram 4 shows the block diagram of the exciter - power supply circuit board. Signal paths and power lines are shown in solid lines, the control signals in dotted lines. The numbers between brackets (.) in the text refer to the numbers in the block diagram. The following main parts can be distinguished.

- Main oscillator loop.
- Modulator loop.
- Receiver power supply.
- Transmitter power supply.

a. Main oscillator loop

The main frequency determining part of both transmitter and receiver is the voltage controlled oscillator (VCO) (1). The frequency range is 41.5...96.475 MHz, divided into three bands. Via buffer amplifier (2) the oscillator signal is used

as the local oscillator signal for the first receiver mixer. Via buffer amplifier (3) the signal is connected to transmitter mixer (4), where it is mixed with an 11.5 MHz signal from the modulator loop. From the various mixing products thus obtained the required transmitter signal is filtered by the receiver input filters (see para. 2.3).
To stabilize the VCO frequency on the desired value, a phase locked loop (PLL) is used. Via buffer amplifier (5) and fixed divider (6) the VCO signal is connected to the synthesizer IC (7). Fixed divider (6) is necessary because the maximum frequency of the synthesizer IC is approx. 8.5 MHz.
The synthesizer IC contains:
. a fixed divider
. a programmable divider
. a phase discriminator
. a lock detector
The fixed divider divides the 6 MHz reference signal (derived from a very stable crystal oscillator) down to 25 kHz or 12.5 kHz. The programmable divider (programmable between 2560 and 5118) divides the VCO also down to 25 kHz or 12.5 kHz. These two signals are compared in the phase discriminator. The resulting tuning voltage is connected via loop filter (8) to the VCO (1), to keep the frequency at the desired value. If the loop is not synchronous, the lock detector generates an alarm signal that activates the NOGO indication on the front panel display.
The programmable divider obtains the necessary information from control circuit (9), which in turn obtains its information via the data bus from the LF-control PCB. In this way the programmable divider is set to the correct division for any selected frequency.

b. <u>Modulator loop</u>

The amplified microphone signal, supplied by the LF-control PCB is connected via amplifier (10) to VCO (11). The frequency modulated 11.5 MHz signal is connected via buffer amplifiers (12) and (13) to transmitter mixer (4).
During reception VCO (11) is tuned to 11.1 MHz. Via switch (14) and buffer amplifier (15) this signal is used as the local oscillator for the second mixer of the receiver.
When tuning the RF filters of the receiver input circuits (see para. 2.3) a transmitter signal of the correct frequency is needed, but the receiver must be operative too. In this case switch (14) selects a 12 MHz signal from the reference circuit as a local oscillator signal for the receiver. This results in a second IF of 500 kHz instead of

400 kHz for the receiver, but the relevant circuits are sufficiently broadband to accept this.
To stabilize the frequency of the VCO (11) a phase locked loop of the same type as used in the main oscillator loop is used. Via buffer amplifiers (12) and (16) and divide-by-two circuit (17) the VCO signal is connected to the synthesizer IC (18). Here the 6 MHz reference signal is divided by 240 to obtain 25 kHz. In the programmable divider the 11.1 MHz signal is divided by 444 or the 11.5 MHz signal by 460 to obtain 25 kHz. The fixed divider (17) is necessary because of the max. 8.5 MHz input frequency of the IC (18). The tuning voltage is connected to the VCO (11) via the loop filter (19).

c. Receive power supply

The power for the transceiver can be supplied by the internal battery or from an external power supply. If an external power supply is available relay (20) is energized and power is taken from the external power supply. Switching on and off is done with the volume control/on-off switch on the front panel. This switch operates relay (21). Relay (21) is a polarized relay that only takes current to change its position. The battery voltage is monitored by circuit (22) that switches off the transceiver when the battery voltage drops below approx. 8.6V. The battery voltage (limited power) is also available for external equipment via the 10-pole audio connector on the front panel.
The power supply itself is switching convertor (23), delivering stabilized output voltages of +5V, -5V and +30V. The switching frequency depends upon the battery voltage and the load and may vary between 30 kHz and 90 kHz.
The +5V (limited power) is also available for external equipment via the 10-pole connector at the side of the transceiver.

d. Transmitter power supply

The transmitter power supply (24) is also a switching convertor, synchronised by a 60 kHz signal taken from the LF-control PCB. The convertor only operates during transmitting (PTT-info from control circuit (9)).
The output voltages are +5V (taken from the receiver power supply), +15V for the transmitter power amplifier and -35V for the diodes used as band-switches. When the transmitter output power is raised to 5W (burn-through power) the +15V is raised to +24V and the -35V to -60V.

2.5 LF - Control circuit board
(see diagram 5)

Diagram 5 shows the block diagram of the LF-control circuit board. Signal paths are shown in solid lines, the control signals in dotted lines. The numbers between brackets (.) in the text refer to the numbers in the block diagram. The circuit board contains two largely unrelated parts:
. LF circuits
. Control circuits

a. LF circuits

The AF output of the receiver is connected via amplifier (1) to low-pass filter (2) and high-pass filter (3). These filters limit the speech pass-band to 300...3400 Hz. Switch (4) disconnects the receiver from the telephone when the squelch is enabled and there is no incoming signal, and also during transmitting.
The gain of amplifier (5) can be varied over 20 dB by the volume control switch on the front panel.
There are separate output amplifiers (6) and (7) for the 6-pole and the 10-pole audio connector.
When the retransmission cable is connected to the 10-pole audio connector, switch (8) by-passes the volume control for amplifier (7) so that a standard line level is obtained.
The receiver signal is also connected to 150 Hz filter (9). If a 150 Hz signal is present, detector (10) enables trigger (11). Via the control circuit (12) and the overall processor control the receiver signal is switched through to the telephone.
The microphone signals from the 6-pole or the 10-pole audio connectors are amplified by circuits (13) and (14). The gain of these amplifiers is increased in the WHISPER mode (position W of the volume control). Via amplifier (15) and 300 Hz high-pass filter (16) the microphone signal is connected to clipper (17). This circuit removes the peaks of the speech signal and so raises the average level. Low-pass filter (18) limits the frequency range to 3400 Hz. In circuit (19) the 150 Hz squelch tone is added before the signal is connected to the modulator loop. Also a sidetone signal is connected to the telephone circuit.
For the tone squelch signal a 1500 Hz signal is taken from the reference circuit. Via divide-by-ten circuit (20) a 150 Hz square wave is obtained. With switches (22) and (23) in the transmit position, filter (9) changes the square wave into a sine wave. This 150 Hz signal is added to the transmitter modulation.
Via divide-by-two circuit (21) the 750 Hz alarm tone is obtained from the 1500 Hz signal.

This alarm tone can be heard after switching-on, during tuning and when a NOGO condition occurs.
The handset connected to the 6-pole audio plug can be equipped with a selector switch for the preset channels. Actually this switch selects resistors of varying values (see para. 1.2.4).
To the 10-pole audio connector various types of peripheral equipment can be connected, such as a retransmission cable, an intercom network or a fill-gun. For each type of equipment a different resistor value is used to identify the equipment. The 10-pole supply connector also has this facility.
Analog to digital convertor (24) measures the value of these resistors and sends the information to the control circuit.

b. Control circuits

As central processor a type 80C31 micro-controller is used. The central processor (25) uses a 6 MHz clock signal. This clock signal is obtained from the 12 MHz crystal oscillator of the reference circuit via divide-by-two circuit (26). Circuit (27) takes care of a complete reset of the processor after power is applied when switching on.
The processor memory consist of the following parts:
- 8 Kbyte random access memory (RAM) (28), used for storing data used in the program.
- 64 Kbyte read-only memory (EPROM) (29) containing the main program.
- 256 byte programmable read-only memory (EEPROM) (30), for storing the data of the preset channels.

For communication between the processor and the control circuits in other parts of the set the input/output circuits (31), (32), (33) and (34) are used. There are four databusses:
- Databus 1, for transmitter and receiver.
- Databus 2, for exciter and power supply.
- Databus 3, for the front panel.
- Databus 4, for the LF circuits.

2.6 Reference circuit board
(see diagram 6)

Diagram 6 shows the block diagram of the reference circuit. The numbers between brackets (.) in the text refer to the numbers in the block diagram.
The main oscillator (1) is a 12 MHz temperature compensated crystal oscillator (TCXO). Via buffer amplifier (2) 12 MHz signals are sent to the control circuit and to the modulator loop.

A 6 MHz reference signal for the main synthesizer loop and the modulator loop is obtained by divide-by-two circuit (3). Further division by ten in circuits (4) and (5) is used to generate the 60 kHz signal used in the power supply. Via dividers (6) and (7) a 1500 Hz signal is obtained for use in the LF circuits (alarm signal and tone squelch).

2.7 Front panel circuit board
(see diagram 7)

Diagram 7 shows the block diagram of the front panel circuit. The numbers between brackets (.) in the text refer to the numbers in the block diagram.
The keyboard (1) has 14 keys. Thirteen of these are connected to control circuit (2), only the "Z" (Zeroise) key (7) has a separate connection. Display driver (3) determines which segments of the front panel display (4) are energised. The display driver receives the necessary information direct from the databus. Amplifier (5) drives the LED's that provide back-lighting of the display. The brightness can be varied in three steps. The back-lighting extinguishes 10 seconds after the last keystroke.

2.8 Mechanical construction

The backbone of the SPIDER manpack consist of a cast aluminium frame with an upper, a lower and a rear compartment. The rear compartment is used for the battery block. It can be closed with a hinged cover. The upper and lower compartments contain printed circuit boards with most of the electronic circuits. The upper compartment contains the transmitter/ receiver PCB, the lower compartment the LF/control PCB and the Exciter/power supply PCB. The reference circuit is mounted on the exciter/power supply PCB. Upper and lower compartment are closed by a cover, mounted with four screws.
The front panel is connected to the frame with two screws. The front panel contains the display, the keyboard, audio and antenna connectors and the volume control/on-off switch. For connections between the PCB's, use is made of flexible printed circuits instead of conventional wiring.

CHAPTER 3

FIELD MAINTENANCE

3.1 General

This chapter provides instructions for testing, trouble-shooting and simple repair work on the SPIDER manpack transceiver.
Two separate steps in field maintenance can be distinguished:
a) Testing and repair in the field. This is described in para. 3.4 and 3.5.
b) Testing and repair in the (mobile) workshop. This is described in para. 3.6, 3.7 and 3.8.

3.2 Responsibilities

1. Checking that operator maintenance has been carried out properly and if necessary giving advice for improving it.

2. Inspecting the equipment on its operational condition, using the available test equipment and methods.

3. If the equipment is not operational, localizing the defect down to a defective main component, such as a handset, headset, antenna tuning unit or transceiver.

4. Replacing the defective main component by a non-defective one from the available stock.

5. Taking the defective main component to the workshop and repairing it, in as far as the field maintenance engineer is authorised to do so.

6. Sending defective main components that cannot be repaired locally, or defective PCB's to the depot maintenance workshop for repair.

WARNING: Do not remove the covers of the transceiver and replace PCB's in the field! This must be done in a properly equipped workshop, located either in a building or in a shelter mounted on a truck. The PCB's can be damaged easily either by rough handling or by electrostatic discharge.

3.3 Test equipment

To test the radio sets of the SPIDER family a special test box is used. This test box offers the following facilities:

. Checking DC voltages (battery or power supply voltage).
. Checking receiver sensitivity.
. Checking transmitter output.
. Checking antenna matching.

For this purpose the following circuits are incorporated in the test box:

a. A signal generator capable of producing a signal on the frequencies:

32.000 MHz
38.400 MHz
44.800 MHz
51.200 MHz
57.600 MHz
64.000 MHz
70.400 MHz
76.800 MHz
83.200 MHz
89.600 MHz
96.000 MHz
102.400 MHz

These signals are so weak that they can only be detected by a receiver of sufficient sensitivity.

b. A measuring circuit for DC voltages.
This circuit uses a row of light emitting diodes as indicator instead of a moving coil instrument, as the latter is too fragile for use in the field. The circuit is used in all tests.

c. An audio detector used to measure the receiver noise output during the sensitivity test.

d. A reflectometer circuit used to measure the transmitter output power and the reflected RF power caused by antenna mismatch.

e. A 50-ohm dummy load used to replace the antenna during transmitter output power measurements and for "off the air" testing.

f. An alarm LED to indicate a wrong connection during the transmitter output lower test.

g. A range switch to select the various tests.

h. Connectors and cables to connect the test box to the equipment under test.

j. A dry or rechargeable 12 Volts battery with a stabilizer circuit for the power supply of the testbox.

The testbox has the following controls, connectors and cables (see diagram 8):

Control or Connector	Symbol	Explanation
Range switch	1 OFF	Used to select the various tests. - Testbox switched off, (Nicad battery can be charged,if used.)
	2	- Battery check of test box.
	3	- Test of power supply voltage of the transceiver (battery test in portable set, stabilizer circuit in vehicular sets). DC voltage measurements possible, using cable 04. Voltage range 10...30 V DC.
	4	- Indication of AF output of receiver under test. Part of receiver sensitivity test.
	5 — R	- A weak RF signal is connected to the receiver under test. This results in a reduction of the noise output of the receiver, as measured in position 4 of the switch.
	6	- No signal to receiver. Test of the squelch circuit (de-activated).
	7	- Weak tone modulated signal to receiver. Test of the squelch circuit (activated).
	8	- Transmitter output test (low power).
	9 — T	- Test of antenna matching (using low power).
	10	- Transmitter output test (high power, not for portable transceiver).
	11	- Test of antenna matching (using high power).
	12 Ω	- Resistance measurement, using the (optional) adaptor unit.

Control or Connector	Symbol	Explanation
Coax. Connector	RF TO REC.	Output of the signal generator of the testbox. To be connected to the antenna connector of the set under test during the receiver sensitivity test, using cable 01
Coax. Connector	IN — TX POWER	Input of the reflecto-meter circuit. To be connected to the antenna connector of the set under test during the transmitter output test and the antenna matching test, using cable 01
Coax. Connector	OUT — TX POWER	Output of the reflecto-meter circuit. To be connected to the 50-ohm load during the transmitter output test and with the antenna during the antenna matching test.
Coax. Connector	50 Ω LOAD	Input of the 50-ohm dummy load used during the transmitter output test. Use the short coaxial cable 02 to connect "50 Ω LOAD" with "TX POWER OUT".
Audio Connector	HANDSET	The telephone handset of the set under test may be connected here. During the receiver test noise is heard. The handset is not necessary for testing.
10-Pole Connector	SPIDER	This connector is connected to the 10-pole audio connector of the transceiver under test, using cable 03. When using cable 04 voltage checks are possible.
Alarm LED	CHANGE CABLE 01	If the transmitter is switched on (test 8... 11) and no cable is connected to "TX POWER IN" this LED lights.

Control or Connector	Symbol	Explanation
Indicator LED's	1...16	These LED's are used in all tests as an indicator of the result obtained. Basically the LED's are part of a voltmeter circuit. Each LED corresponds to a certain voltage, LED "16" with the highest voltage, LED "1" with the lowest. Two adjoining LED's light for "in between" voltages.

Cable	Symbol	Explanation
Long coax. cable	01	Used to connect the antenna connector of the set under test with either "RF TO REC" or "TX POWER IN".
Short coax. cable	02	Used to connect "TX POWER OUT" with "50 Ω LOAD".
Audio cable	03	Used to connect the 10-pole connector of the transceiver under test with connector "SPIDER".
Cable with test probe	04	Used for voltage measurements. Range 10...30 V DC. Connect the probe to +, the earth wire to -. RF voltage checks are also possible.
Adaptor unit (optio-nal), with test leads	05	To be mounted on con-nector "SPIDER". Offers additional voltage and resistance ranges. See manual of test box for details.

3.4 Test Procedure Manpack

The procedure is given in the form of tables. The first column gives the sequence number of each test to be performed.
The second column - operation - states what operations are to be performed.
The third column - normal result - states the result the operation should have if all is well.
The fourth column - wrong - indicates the item number of the trouble shooting procedure (paragraph 3.5) that should be consulted to eliminate the fault.
Before starting the test, check that the transceiver is switched off.

Connect the testbox as shown in diagram 9 fig. a):

- "RF TO REC." via cable "01" to antenna connector of the transceiver.
- "SPIDER" via cable "03" to 10-pole audio connector of the transceiver.
- Handset to connector "HANDSET" of the testbox.
- Range switch of the testbox to position "1".

No.	Operation	Normal result	Wrong
1	Set range switch of the testbox to "2".	LED 12...16 lights.	Para. 3.5 item 1
2	Set volume control switch of the transceiver to "3". Set range switch of the testbox to "3".	Alarm tone from handset (max. 4 seconds), followed by noise. LED 2...16 lights.	Para. 3.5 item 2
3	Select channel 0 of the transceiver and set the frequency to 32.000 MHz, no squelch.	Alarm tone from handset (max. 4 seconds), followed by noise.	Para. 3.5 item 2

No.	Operation	Normal result	Wrong
4	Set range switch of the testbox to "4". Adjust volume control switch of the trans-ceiver so that one or two of the LED's 10...15 lights.	Noise from handset adjust-able with volume control switch.	Para. 3.5 item 3
5	Set range switch of the testbox to "5".	Less noise from handset. LED 1...7 lights. The number of the LED that lights must be less than half the number of the LED in test 4.	Para 3.5 item 4
6	Repeat test no. 4 and 5 for the following fre-quencies: 38.400 44.800 51.200 57.600 64.000 70.400 76.800 83.200 89.600 102.400	Same as test no. 5. Note: after a frequency change the alarm tone is heard in the handset. Wait till this has stopped (max. 4 seconds).	Para. 3.5 item 4
7	Set range switch of the testbox to "6". Switch on the squelch of the transceiver.	No noise from handset. LED 16 lights.	Para 3.5 item 5
8	Set range switch of the testbox to "7"	LED 1...4 lights. Note: this test on 102.400 MHz only!	Para 3.5 item 6

No.	Operation	Normal result	Wrong
9	Disconnect cable "01" from "RF TO REC." and connect the cable to " TX POWER IN". Connect "TX POWER OUT" with "50Ω LOAD", using cable "02". See diagram 9 fig. b. The transceiver is still tuned to 102.400. Set the transceiver for high power (PWR 3).		
10	Set range switch of the testbox to "8".	LED 5...16 lights.	Para 3.5 item 7
11	Repeat test no. 10 for the following frequencies: 90.400 80.400 70.400 60.400 50.400 40.400 30.400 (Other frequencies may be used if desired)	LED 5...16 lights. Note: after a frequency change the transceiver may need up to 4 seconds to readjust all tuned circuits. During this time the alarm tone is heard in the handset and LED 1 lights.	Para 3.5 item 7
12	Remove cable "02". Mount the antenna matching unit (AMU) plus antenna on plug "TX POWER OUT". Transceiver frequency is still 30.400 MHz	LED 5...16 lights. (Note which one)	Para. 3.5 item 7

No.	Operation	Normal result	Wrong
13	Set range switch of the testbox to "9"	LED 1...16 lights. (The same, or lower number as during test 12, never higher).	Para 3.5 item 8
14	Repeat test 12 (range switch to "8") and 13 for the following frequencies: 40.400 50.400 70.400 90.400 100.400	See test 12 and 13.	Para 3.5 item 8
15	Set the range switch of the test box to "1". Set the volume control of the transceiver to "OFF" Remove all test cables.		

Note: switch positions "10" and "11" of the test box are not used when testing this set. Position "12" is for fault tracing only.

3.5 Trouble shooting in the field.

The trouble shooting procedure in this paragraph should not be used on its own. Always start with the test procedure described in paragraph 3.4. When during this test procedure a deviation occurs, refer to the indicated item of this paragraph.

1. LED 1...11 lights (or none): battery of test box flat. Before starting the test recharge or replace the battery.

2. LED 1 lights: battery exhausted. Replace or recharge. Lamp 2, 3 or 4 lights: battery almost exhausted. Alarm tone does not stop and/or NOGO indicated by display: replace transceiver.

3. Not possible to adjust the volume control so that one of the LED's 10...15 lights, or incorrect operation of the volume control: replace transceiver.

Note: the LED's indicate the noise output of the receiver. For this reason the LED's may flicker, or adjacent LED's may light now and then. This is not a fault.

4. LED 8...15 lights: insufficient sensitivity of receiver. Replace transceiver.

5. Incorrect operation of squelch: replace transceiver.

6. Incorrect operation of squelch circuit: check if frequency of 102.400 MHz is selected. Still wrong: replace transceiver.

7. LED 1...4 lights: transmitter output too low or zero. Check battery. Battery O.K.: check if PWR 3 is selected. Still wrong: replace transceiver.

8. Wrong LED lights: check the antenna. Antenna O.K.: replace AMU.

3.6 Workshop equipment.

Repair of the SPIDER manpack transceiver at field maintenance level is done by localizing the fault down to a PCB, and then replacing this defective PCB by a good one. As the PCB's can be easily damaged both by rough handling and by electrostatic discharge (ESD), this must be done in a properly equipped workshop. Such a workshop can be located in a building, but also in a shelter mounted on a truck. The following equipment should be available:

. A workbench suitable for working on ESD sensitive components. Such a workbench should have an anti-static or conductive surface. Persons at the work-bench should be earthed via a wriststrap and a resistor. All equipment should be earthed.

. An adjustable stabilized power supply capable of supplying 0...35V DC by up to 4A.

. A universal volt-ampere - ohm meter.

3.7 Test procedure transceiver

To be issued later.

3.8 Trouble shooting in the workshop

To be issued later.

3.9 Replacing printed circuit boards

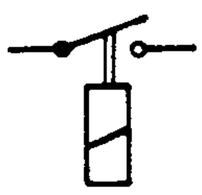
To be issued later.

3.10 Adjusting the battery holder

To be issued later.


LIGHT EMITTING DIODE

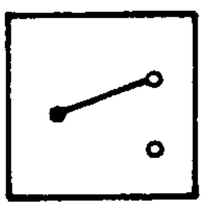

PUSH-BUTTON SWITCH

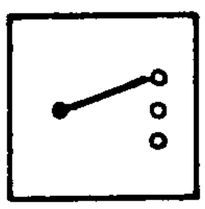

RELAY

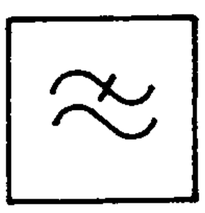

ANTENNA

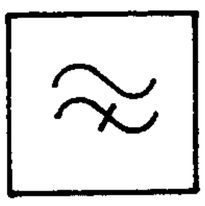

CONTACT

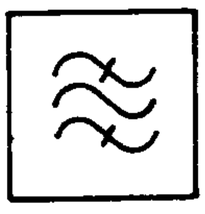

TERMINAL

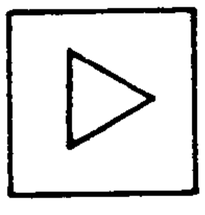

SWITCH

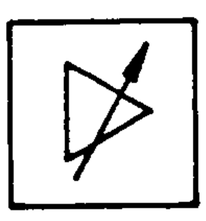

SWITCH

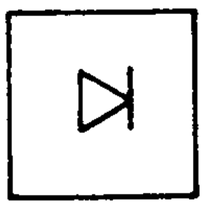

LOW-PASS FILTER

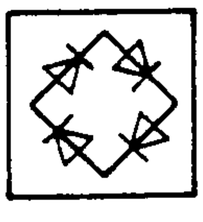

HIGH-PASS FILTER

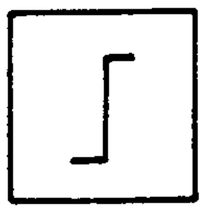

BAND-PASS FILTER

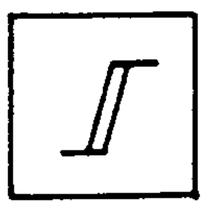

AMPLIFIER

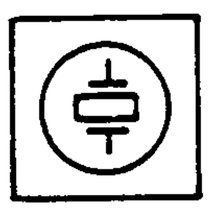

VARIABLE AMPLIFIER

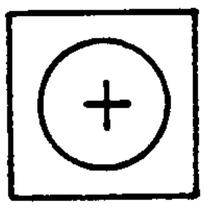

DETECTOR


MIXER


LIMITER

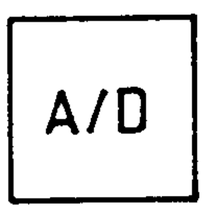

TRIGGER


CRYSTAL OSCILLATOR

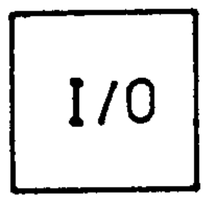

AUDIO MIXER

DIVIDE BY TWO CIRCUIT

DIGITAL-TO-ANALOG CONVERTER

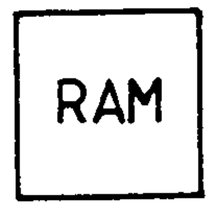


ANALOG-TO-DIGITAL CONVERTER



INPUT / OUTPUT CIRCUIT

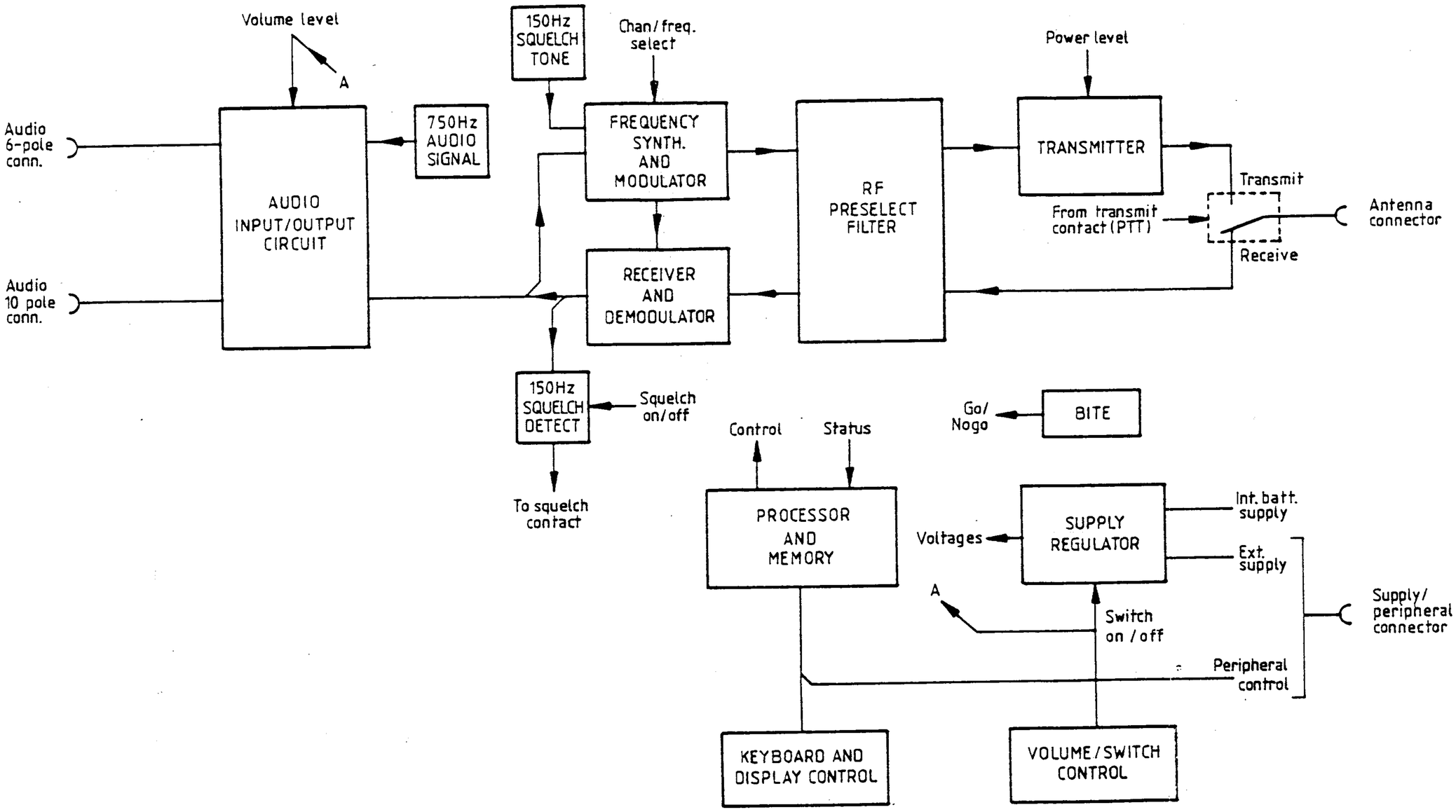
VOLTAGE CONTROLLED OSCILLATOR



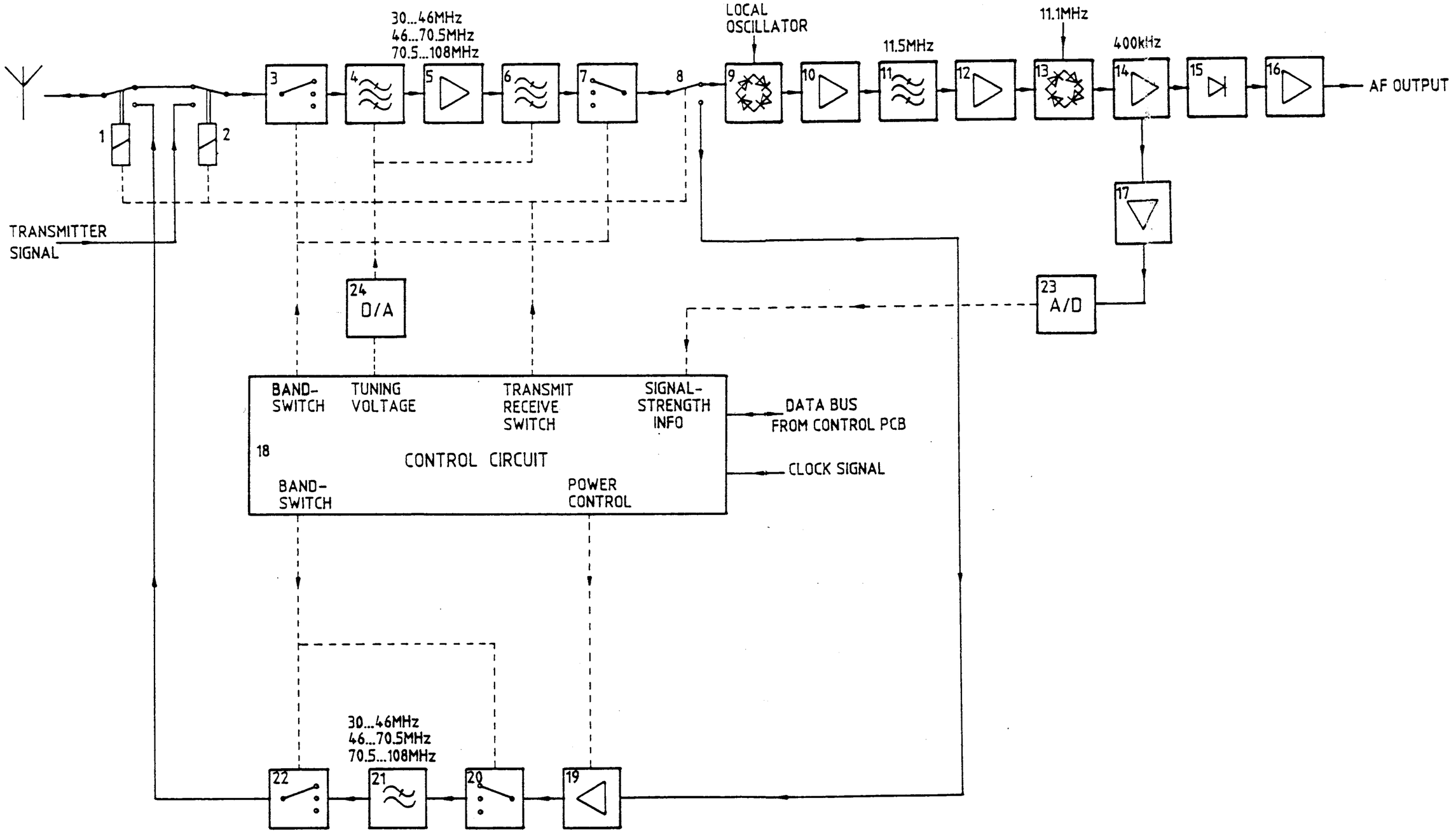
RANDOM ACCESS MEMORY

ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY

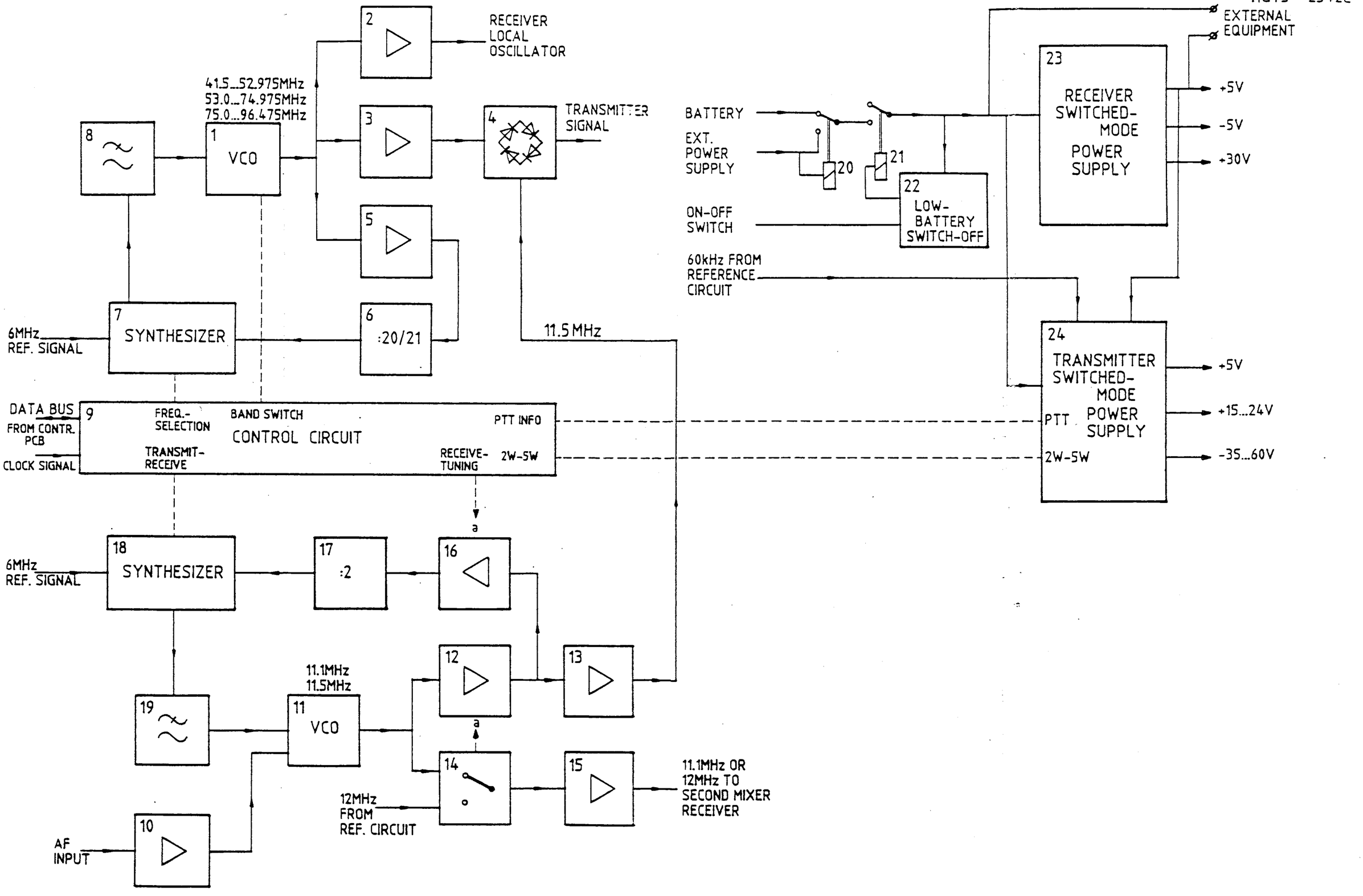
ELECTRICALLY ERASABLE PROGRAMMABLE READ-ONLY MEMORY



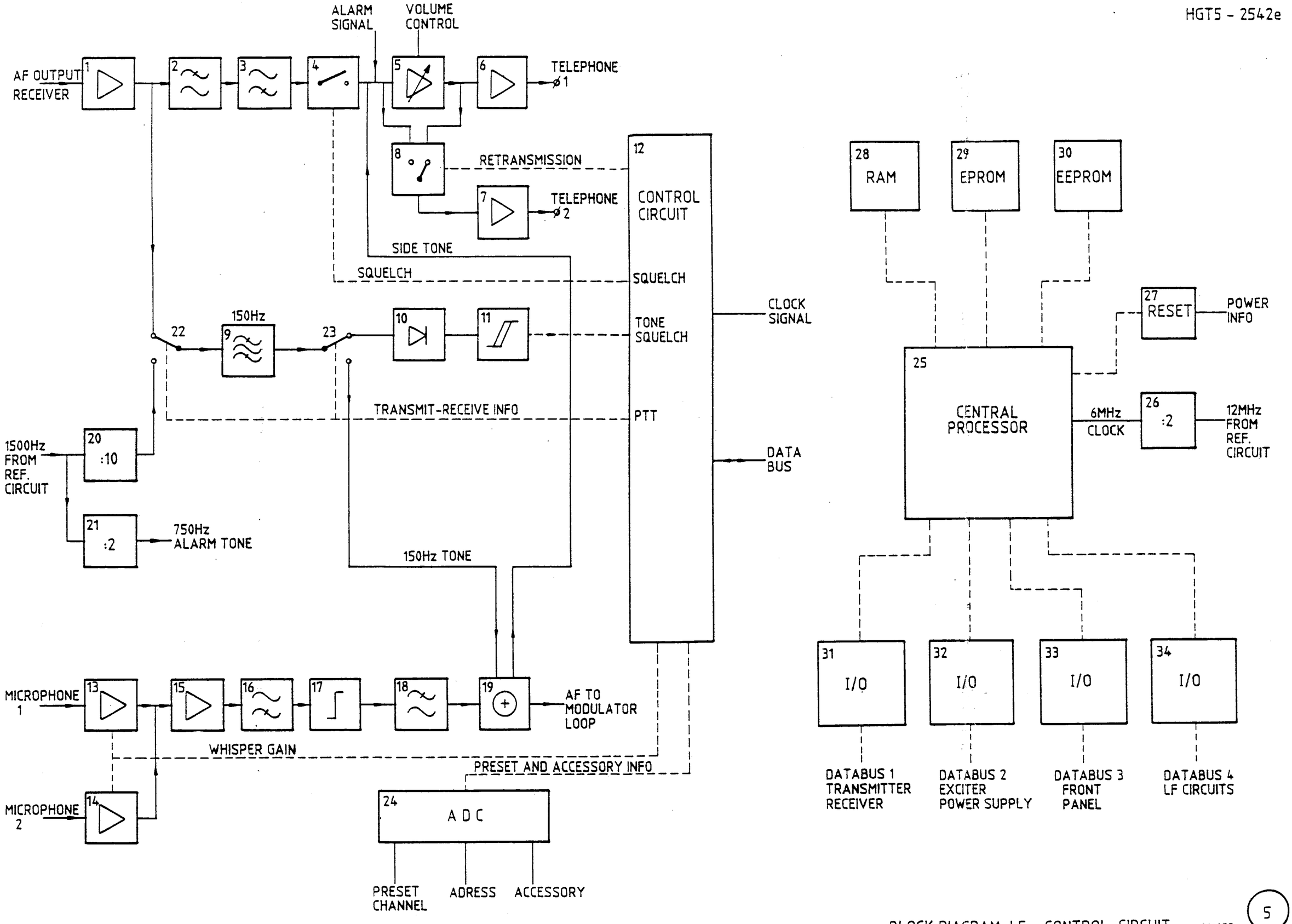
BLOCK DIAGRAM TRANSCEIVER 901017



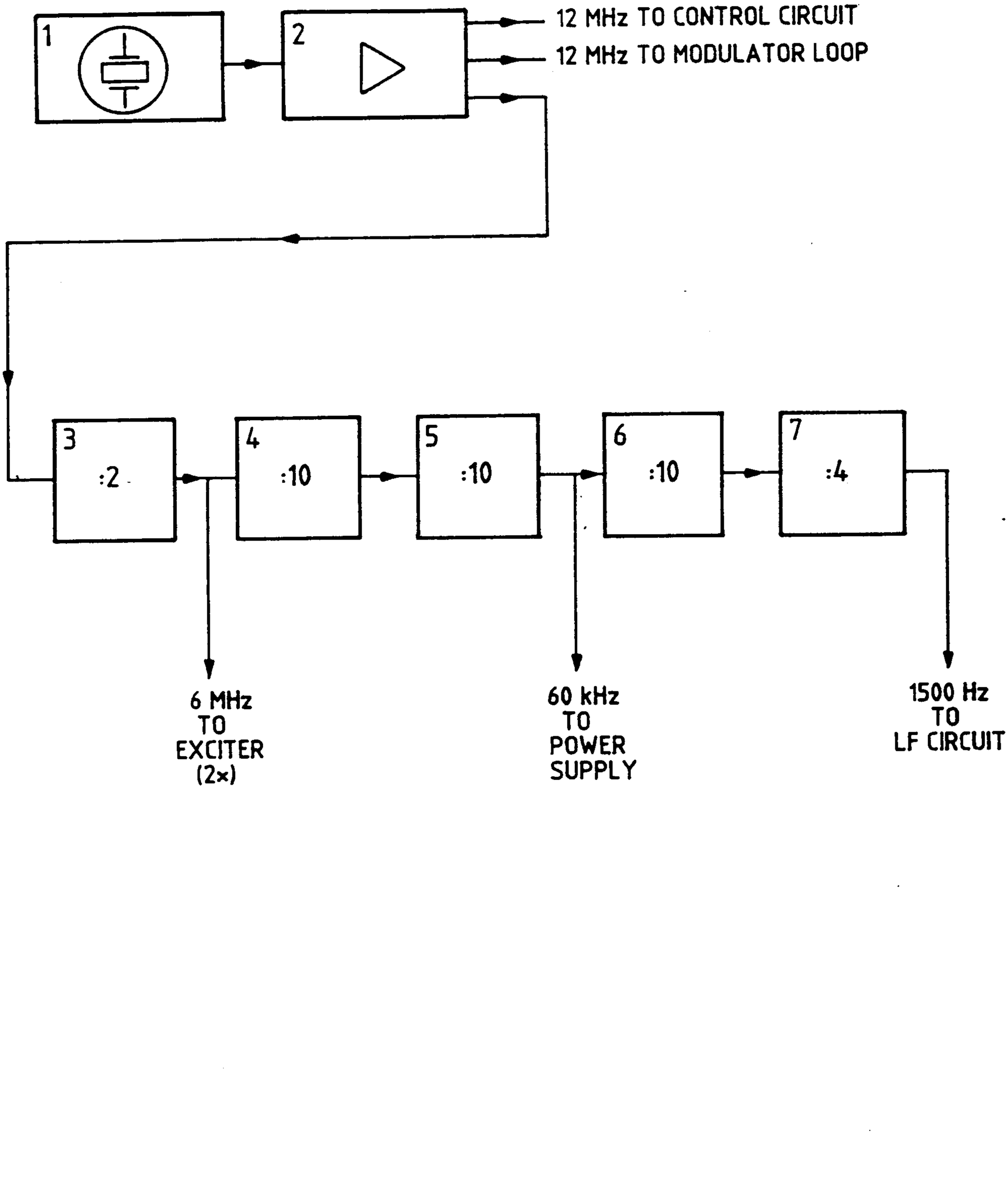
BLOCK DIAGRAM TRANSMITTER - RECEIVER 901029



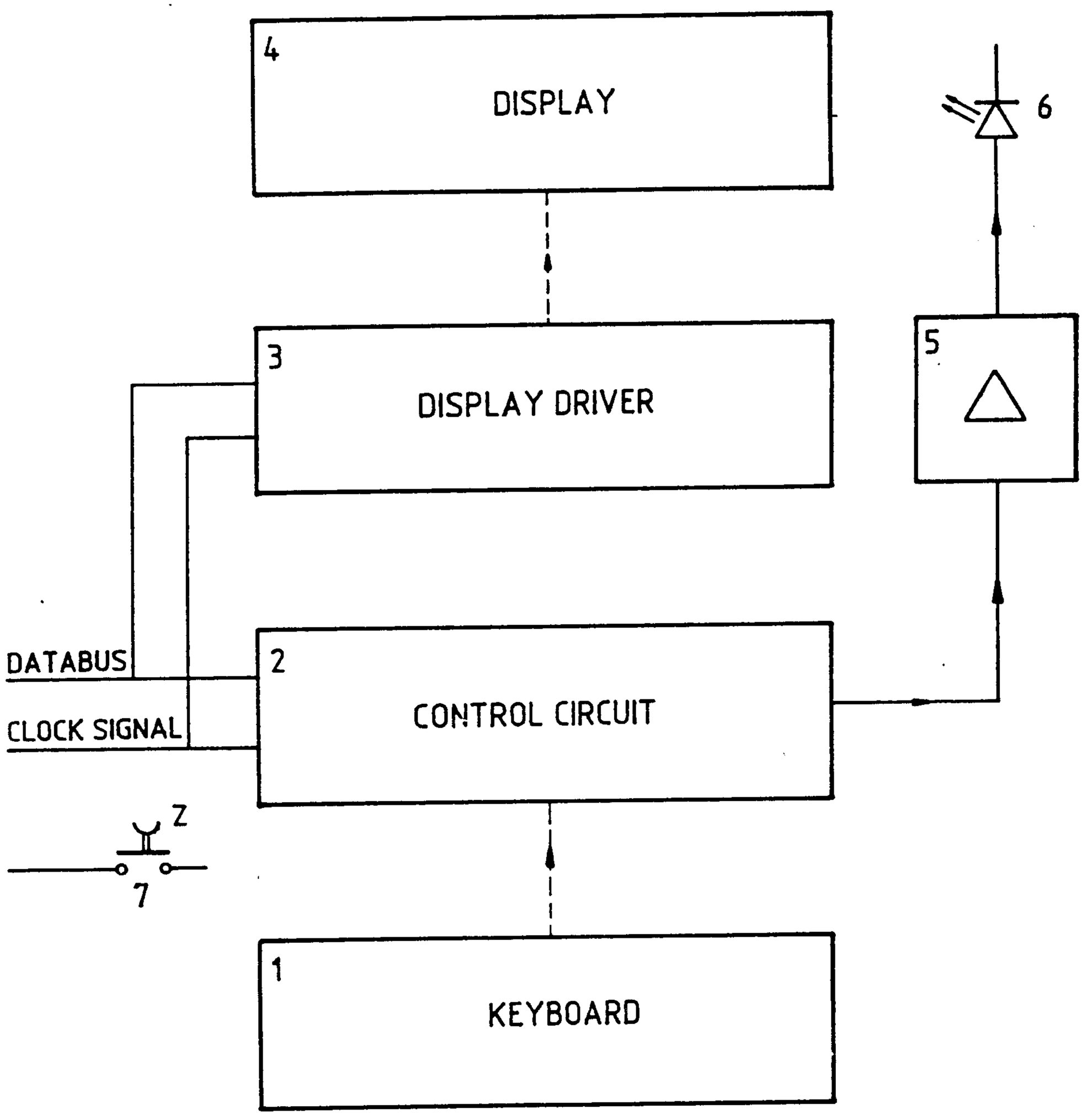
BLOCK DIAGRAM EXCITER - POWER SUPPLY 901029



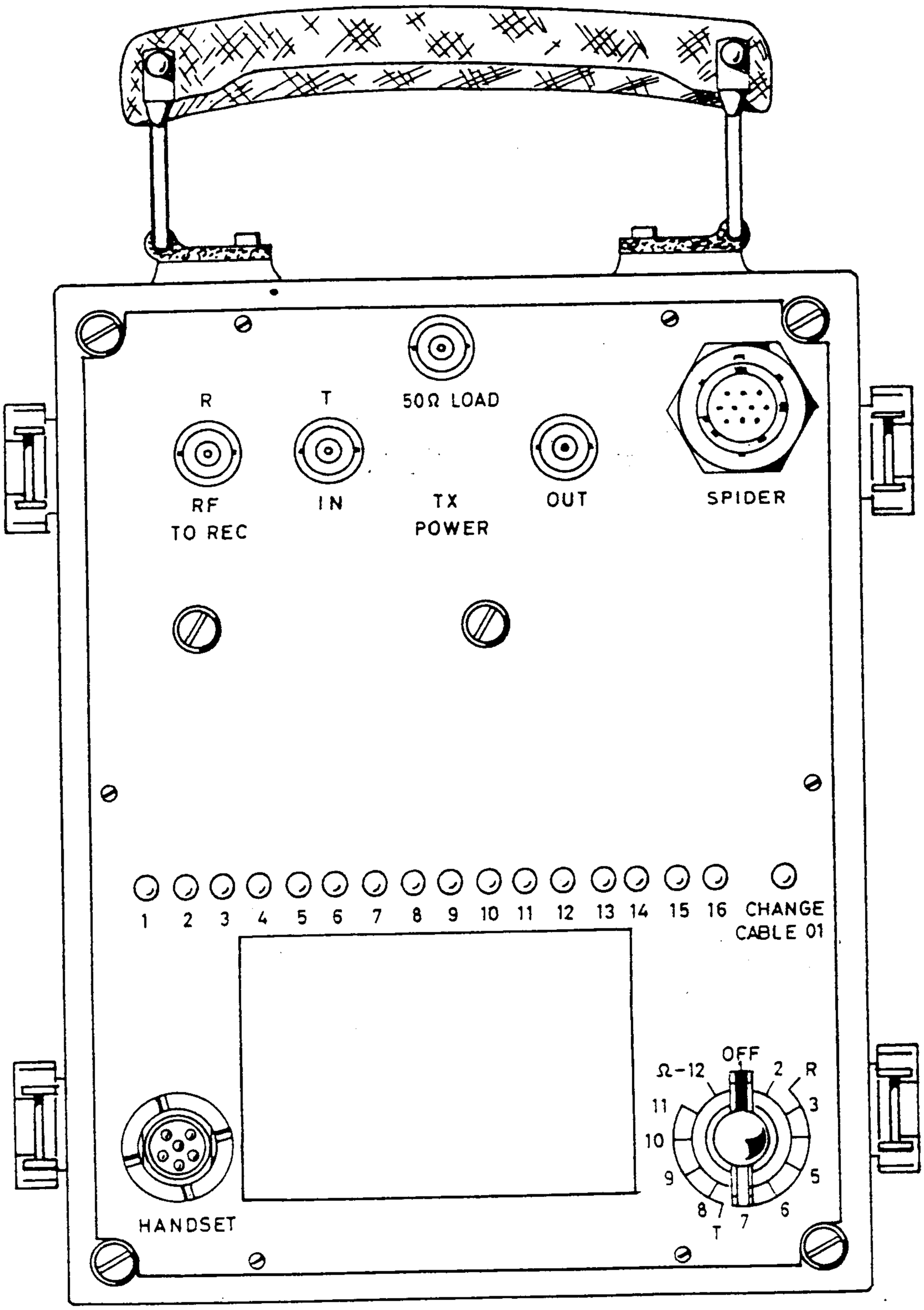
BLOCK DIAGRAM LF - CONTROL CIRCUIT 901029



BLOCK DIAGRAM REFERENCE CIRCUIT 901029



BLOCK DIAGRAM FRONT PANEL 901029


R
RF
TO REC
T
IN
50Ω LOAD
TX
POWER
OUT
SPIDER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CHANGE
CABLE 01
HANDSET
OFF
Ω-12
2
R
3
5
6
7
8
9
10
11
T