SPENDEX 40

SPEECH ENCRYPTION DECRYPTION EQUIPMENT TYPE UA 8251/00 and /01

Limited Maintenance Manual

PHILIPS USFA BV

NATO Confidential

Document No. 9922 154 13431
Issue date: 29-09-88
Printed in The Netherlands

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Abbreviations

CIK	Crypto Ignition Key
CKG	Check Key Generator
IVSN	Initial Voice Switched Network
KDC	Key Distribution Centre
PKG	Primary Key Generator
Ptt	Press to talk
RKG	Receive Key Generator
STU-II	Secure Telephone Unit (second generation)

Definitions

CIK-module:
Programmed module, unique per terminal, required for crypto operation.

Full Duplex:
Mode of transmission in which at both ends of a connection data are transmitted and received simultaneously.

Half Duplex:
Mode of transmission in which alternately data are transmitted at one end of a connection and received at the other.

KDC mode:
Encryption mode in which KDC call variables are used.

Net mode:
Encryption mode in which Net variables are used.

Pulse Dialling:
Dialling mode in which during the dialling of a telephone number a series of pulses is transmitted for each digit.

Secure Telephone Unit:
Speech Encryption/Decryption Equipment of the type TSEC/KY-71A.

Tone Dialling:
Dialling mode in which during the dialling of a telephone number 2 tones with a different frequency are transmitted for each digit.

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1 INTRODUCTION

1.1 General

This manual contains instructions for the limited maintenance of the speech encryption/decryption equipment SPENDEX 40, types UA 8251/00 and UA 8251/01. The fault finding and repair procedures are restricted to the location and replacement of defective exchangeable units, if any.

1.2 Technical description

The speech encryption/decryption equipment SPENDEX 40 is an apparatus with which it is possible to achieve secure communication (speech and data) via telephone lines and radio contacts. For secure communication via telephone lines the apparatus is provided with an internal line modem, whereas for secure communication via radio contacts a special radio modem need to be connected. The SPENDEX 40 can also be used as a normal telephone for nonsecure communication.

SPENDEX 40 can operate in Pulse Dialling and Tone Dialling mode. With an appropriate network it is possible to set up in the Tone Dialling mode a connection with a certain precedence level. In this case a choice can be made of 4 different levels, viz. priority, immediate, flash and flash override.

SPENDEX 40, type UA 8251/00, is equipped with a V26/V26bis modem. With an apparatus of this type it is possible to achieve secure communication in the 2-wire Half Duplex or in 4-wire Full Duplex transmission mode. A type UA 8251/00 apparatus can operate in the Net and KDC mode. In the KDC mode and in the NET mode, but only with a key variable in compartment 00, an apparatus can cooperate with a STU-II unit (Secure Telephone Unit, second generation).

SPENDEX 40, type UA 8251/01, is fitted with a V22bis modem. With this type of equipment secure communication can be achieved in the 2-wire Full Duplex transmission mode. An UA 8251/01 apparatus can only operate in the Net mode.

Remark: equipment types UA 8251/00 and UA 8251/01 cannot cooperate with each other in any mode whatsoever.

1.3 Mechanical construction

SPENDEX 40 is a compact apparatus built up of modules and is primarily designed for office use. For mobile use a shock mounting is available.

2 TECHNICAL DATA

2.1 Identification

Name : Speech Encryption/Decryption Equipment SPENDEX 40
Type : UA 8251/00 or UA 8251/01
Manufacturer: Philips Usfa B.V., Eindhoven

2.2 Speech digitising

Linear Predictive Coding (LPC-10) according to STANAG 4198

2.3 Data interface

Signal level: according to CCITT-recommendation V24/V28 or
EIA-standard RS232-C
Bit rate : 2400 bit/s

2.4 Modem interface

Signal level: according to CCITT-recommendation V24/V28
Bit rate : 2400 bit/s

2.5 Line interface

Speech:
- signal form : analogue
- frequency range : 80...3400 Hz

Data (equipment type UA 8251/00):
- signal level : according to CCITT-recommendation V26/V26bis
- bit rate : 2400 bit/s
- transmission rate : 1200 Bd
- carrier frequency : 1800 Hz
- transmission level: adjustable from -23 dB to +4 dB
- reception level : -43 dB to 0 dB

Data (equipment type UA 8251/01):
- signal level : according to CCITT-recommendation V22bis
- bit rate : 2400 bit/s
- transmission rate : 600 Bd
- carrier frequency : 1200 Hz (low channel)
2400 Hz (high channel)
- transmission level: adjustable from -24 dB to +6 dB
- reception level : -45 dB to 0 dB

2.6 Setting possibilities

Possibility of Half Duplex or Full Duplex transmission mode:
- equipment type UA 8251/00: HD or FD
- equipment type UA 8251/01: FD only

Adjustment of the synchronisation to the internal or external modem: LF/HF

Adaptation to 2-wire or 4-wire connection:
- equipment type UA 8251/00: 2W or 4W
- equipment type UA 8251/01: 2W only

Choice between Pulse Dialling or Tone Dialling: PD/TD

Adjustment of the ringing signal volume: RV1...RV4

2.7 Power supply

Mains voltage	: 110 V or 220 V ± 15%, 47...63 Hz
Power consumption	: 45 W max.
Fuses	: 2 x 110 V/1 A slow or 2 x 250 V/500 mA slow

2.8 Battery

Type	: 3.9 V penlight UA 6303/03
Voltage	: 3.5...4.5 V

2.9 Environmental conditions

Temperature:

- in operation	: -10°C to +50°C
- during storage and transport	: -40°C to +70°C

Relative humidity:

- in operation	: up to 90%
- during storage and transport	: up to 95%

Radiation:
- TEMPEST approved according to AMSG-720B
- the equipment meets the EM-demands according to MIL-STD-461B

Vibration/shock:
When mounted on the shock mounting type UA 8254/00 the equipment meets the vibration and shock demands according to DEF STAN 07-55:
- vibration, test A2
- shock, test A5

2.10 Physical properties

Dimensions : 38.5 cm x 27 cm x 16/23 cm
Weight : approx. 12 kg

3 MODULAR SET-UP (see Fig. 3.1)

3.1 Main assembly

3.1.1 Front panel UA 8312/00

The front panel contains:
- the handset connector
- the data connector
- the fill-gun connector
- the CIK-connector
- the ZEROISE push button
- the SECURE push button
- the keyboard

Furthermore the front panel is provided with 3 filter plates:
- a filter plate (display, keyboard), consisting of the display and keyboard panel with display, LED and feed-through filters for the signals from and to the keyboard interface, the display interface and the LED;
- a filter plate (switches) with feed-through filters for the signals from and to the ZEROISE push button and the SECURE push button;
- a filter plate (handset, data, CIK, fill-gun) with feed-through filters for the signals from and to the handset, a Data Terminal Equipment, the CIK-module and a key variable loading device.

3.1.2 Housing UA 8311/00

The housing consists of 3 compartments:
- the red compartment
- the line interface compartment
- the power supply compartment

On the bottom of the red compartment the mother board has been mounted. This mother board is fitted with connectors for the connection of the connecting board, the synthesis board, the analysis board, the key memory board, the key generator board, the controller board, the timing board and the telephony board.
The line interface compartment accommodates the modem and the line interface board.
The power supply unit is in the power supply compartment.

The housing has 3 filter plates:
- a filter plate (modem/pr.mod.) with feed-through filters for the signals from the mother board to the line interface board and for the signals from the line interface board to the mother board;
- a filter plate (power supply/pr.mod.) with feed-through filters for the power supply voltages to the mother board;
- a filter plate (power supply/modem) with feed-through filters for the power supply voltages to the line interface board.

3.1.3 Connecting board UA 8310/00

The connecting board contains:
- the microphone amplifier
- the low pass filter transmitting side
- the A/D-converter
- the D/A-converter
- the low pass filter receiving side
- the telephone amplifier
- the CIK-interface
- the fill-gun interface
- the CCITT-V28/EIA RS232 data interface
- a clear/secure relay
- the analogue-loop relay
- a +12/+5 V power converter
- a -12/-5 V power converter
- a zeroise switch

3.1.4 Synthesis board UA 8323/00

The synthesis board contains:
- the DFT-processor
- the pitch processor
- synthesis processor 1
- synthesis processor 2
- the vocoder controller
- the vocoder program memory
- the vocoder data memory
- the vocoder address decoder
- a timing circuit
- the master clock signal generator

3.1.5 Analysis board UA 8322/00

The analysis board contains:
- the segmentation buffer
- the pitch buffer
- the speech buffer
- the analysis processor
- a timing circuit
- the slave clock signal generator

3.1.6 Key memory board UA 8321/00

The key memory board contains:
- program memory 2 (U EPROM)
- the zeroise memory
- the key variable memory
- the zeroise circuit
- a zeroise switch

3.1.7 Key generator board UA 8320/00

The key generator board contains:
- the series/parallel converter for the data signal to be encrypted originating from the Data Terminal Equipment
- the key generators transmitting side (PKG/CKG)
- the parallel/series converter for the data signal to be transmitted
- the series/parallel converter for the received data signal
- the key generator receiving side (RKG)
- the parallel/series converter for the decrypted data signal destined for the Data Terminal Equipment
- the alarm circuit

3.1.8 Controller board UA 8319/00

The controller board contains:
- the comsec controller
- program memory 1 (M EPROM)
- the data memory red
- the data memory black
- the address decoder
- the interrupt circuit

3.1.9 Timing board UA 8318/00

The timing board contains:
- the time base
- timer long
- timer short
- the alarm and power-on reset circuit

3.1.10 Telephony board UA 8317/00

The telephony board contains:
- the dialling tone generator
- the dialling pulse generator
- the 2025/2100 Hz answering tone detector
- the 420 Hz pre-emption signal detector
- the on/off-hook detector
- internal-loop switches

3.1.11 V26/V26bis modem UA 8314/01

ONLY IN EQUIPMENT TYPE UA 8251/00

The V26/V26bis modem modulates the signal to be transmitted and demodulates the received signal according to CCITT-recommendation V26/V26bis.

3.1.12 V22bis modem UA 8343/00

ONLY IN EQUIPMENT TYPE UA 8251/01

The V22bis modem modulates the signal to be transmitted and demodulates the received signal according to CCITT-recommendation V22bis.

3.1.13 Line interface board UA 8316/00

The line interface board contains:
- the line output amplifier
- the line input amplifier
- the internal/external modem selector
- the CCITT-V28 modem interface
- the ringing signal detector
- a clear/secure relay
- the external-loop relay
- the 2-wire/4-wire switching relay
- the on-hook relay
- 2 dialling pulse relays

3.1.14 Upper cover UA 8307/00

The upper cover covers the upper side of the red compartment of the housing. In this upper cover also the reed contact of the hook switch is mounted.

3.1.15 Cradle UA 8313/00

The cradle accommodates the handset. The switch arm of the hook switch is mounted in the cradle.

3.1.16 Mains/line filter (back cover) UA 8309/00

The mains/line filter contains:
- the on/off-switch
- the earth connection
- the mains connection with 2 fuse holders
- the line connector
- the modem connector

Furthermore the mains/line filter is fitted with:
- a transformer panel with 2 transformers which take care of a galvanic separation with the line;
- a filter plate (line/modem) with feed-through filters for the signals from and to the line and an external modem;
- a filter plate (battery) consisting of a battery compartment with feed-through filters for the battery voltage;
- a protection panel (mains) and 2 feed-through filters for the

110/220 V mains supply voltage.

3.1.17 Power supply unit UA 8308/00

The power supply unit converts the 110/220 V mains supply voltage into supply voltages of +5 V, +12 V and -12 V.

3.2 Accessories

3.2.1 Handset UA 8252/00

The handset contains the microphone, the telephone and the Ptt (Press-to-talk)-switch. The Ptt-switch need only be used with the type UA 8251/00 equipment during a secure conversation in the Half Duplex transmission mode.

3.2.2 CIK-module UA 8247/00

The CIK-module is a module, provided with the Crypto Ignition Key, which is required to let the equipment operate in a secure mode. Without the CIK-module the apparatus can only be used as a normal telephone for nonsecure communication. The Crypto Ignition Key is stored in an EEPROM and is also maintained there when the CIK-module is not connected to the apparatus. The CIK-module does not contain a battery.

3.2.3 Battery UA 6303/00

3.9 V nonrechargeable lithium battery which sees to it that the contents of the key memory and the zeroise memory remain preserved in case of a power breakdown or when the equipment is switched off. The battery is not charged when the apparatus is switched on.

3.2.4 Fuses

For 220 V:
- 2 x 250 V/500 mA slow 2422 086 01015

For 110 V:
- 2 x 110 V/1 A slow 2422 086 01021

3.2.5 IVSN-line connecting cable UA 8240/01

Line connecting cable to connect a type UA 8251/00 equipment to the NATO-IVSN network.

3.2.6 PTT-line connecting cable UA 8240/00

Line connecting cable to connect an apparatus to a public PTT network.

3.2.7 Mains supply cable 5722 660 30670

Supply cable to connect the 110/220 V mains supply voltage.

3.2.8 Shock mounting UA 8254/00

Shock mounting for use of the equipment in rooms, which are not vibration-free.

3.2.9 Transport case UA 8342/00

Special case to transport the equipment.

4 CIRCUIT DESCRIPTION

This chapter gives a functional description of the various circuits. The circuits are described per module on the basis of the block diagrams of Fig. 4-1, Fig. 4-2 and Fig. 4-3.

4.1 Handset

4.1.1 Microphone

The microphone converts the speech signal into an electric signal. The signal thus obtained is directed to the microphone amplifier on the connecting board.

4.1.2 Telephone

The telephone makes the signal, which comes from the telephone amplifier on the connecting board, audible.

4.1.3 Ptt-switch

The Ptt-switch should be used during a secure conversation in the Half Duplex transmission mode (equipment type UA 8251/00). Every time the Ptt-switch is pressed, the Ptt-signal is activated.

4.2 Front panel

4.2.1 ZEROISE push button

As soon as the ZEROISE push button is pressed, the signals ZERO1N and ZERO2N are activated. The signal ZERO1N is passed on to the comsec controller and the signal ZERO2N to the zeroise circuit on the key memory board.

4.2.2 SECURE push button

As soon as the SECURE push button is pressed, the signals CLRSC1 and CLRSC2 are activated. The signal CLRSC1 is passed on to the comsec controller and the signal CLRSC2 energises the clear/secure relay RE3 on the connecting board.

4.2.3 Keyboard

The keyboard contains 16 keys.

4.2.4 Keyboard interface

The keyboard interface takes care of the coupling between the comsec controller and the keyboard. Moreover the interface makes an interrupt signal INTKEY every time a key is pressed.

4.2.5 Display and LED

The alphanumerical display with 8 characters, as well as the LED are situated behind a window over the keyboard. The LED is to the right of the display and is controlled by the comsec controller.

4.2.6 Display interface

The display interface takes care of the coupling between the comsec controller and the display.

4.3 Connecting board

4.3.1 Microphone amplifier

This amplifier amplifies the analogue signal which comes from the microphone.

4.3.2 Low pass filter transmitting side

The low pass filter transmitting side is the first circuit on the transmitting side of the vocoder. The filter limits the frequency band of the amplified microphone signal to approx. 3600 Hz.

4.3.3 A/D-converter

The A/D-converter samples the signal limited in band width with a frequency of 8 kHz and converts each sample into an a-law code of 8 bits.

4.3.4 D/A-converter

The D/A-converter converts the digital signal, which comes from synthesis processor 2 on the synthesis board, again into an analogue signal.

4.3.5 Low pass filter receiving side

The low pass filter receiving side is the last circuit on the receiving side of the vocoder. The filter limits the frequency band of the analogue signal to approx. 3600 Hz.

4.3.6 Telephone amplifier

This amplifier amplifies the signal destined for the telephone. This signal can be the output signal of the vocoder limited in band width, the output signal of the line input amplifier, the ringing signal, the output signal of the dialling tone generator or the pre-emption signal.

4.3.7 CIK-interface

The CIK-interface takes care of the coupling between the equipment and the CIK-module. When the CIK-module is removed at a moment that the apparatus is in a state, in which the CIK-module should be connected, the interface will produce a CIK-alarm (CIKAL).

4.3.8 Fill-gun interface

This interface takes care of the coupling between the equipment and a key variable loading device. When the key variable loading device is removed at a moment that the equipment is in a state, in which the key variable loading device should be connected, the interface will produce a FILL-alarm (FILAL).

4.3.9 Data interface

The data interface takes care of the coupling between the equipment and a Data Terminal Equipment in accordance with CCITT-recommendation V24/V28 or EIA-standard RS232-C.

4.3.10 Clear/secure relay

The clear/secure relay RE3 is energised as soon as the SECURE push button is pressed or the comsec controller activates the CLRSEC-signal. The comsec controller will activate the CLRSEC-signal after the other party has pressed the SECURE push button.

4.3.11 Analogue-loop relay

For test purposes the comsec controller can energise the analogue-loop relay RE2 by means of the STRE2-signal, as a consequence of which (if clear/secure relay RE3 is energised) the vocoder output is connected with the vocoder input.

4.3.12 Power supply converters

The power supply converters convert the +12 V and -12 V supply voltages into supply voltages of +5 V and -5 V for a number of analogue circuits.

4.3.13 Zeroise switch

As soon as the front panel is removed the zeroise switch is opened, as a consequence of which the zeroise circuit on the key memory board is activated.

4.4 Synthesis board

4.4.1 DFT-processor

Every 22.5 ms the contents of the segmentation buffer on the analysis board are presented 128 times to the DFT-processor. The DFT-processor determines the spectrum by means of a Discrete Fourier Transformation and passes the result on to the pitch processor in serial form.

4.4.2 Pitch processor

Via an harmonic filtering method the pitch processor determines the pitch from the amplitude peaks of the spectrum. As soon as the pitch processor has calculated the pitch, the vocoder controller will be interrupted (INTPIT). After acceptation of the interrupt the vocoder controller will take over the pitch, smooth it and store it in the pitch buffer of the analysis board.

4.4.3 Synthesis processor 1

The moment synthesis processor 1 is ready to receive a frame, the vocoder controller is interrupted (INTSYN); then the vocoder controller collects the oldest frame from the synthesis part of the vocoder data memory and passes it on to synthesis processor 1. As soon as synthesis processor 1 has received the frame, the first part of the synthesis starts. When the signal NFRN is activated synthesis processor 1 is interrupted. After acceptation of the interrupt the results are sent to synthesis processor 2.

4.4.4 Synthesis processor 2

Synthesis processor 2 generates the 8 bit samples initially coded in a-law. Then the samples will be passed on in serial form to the D/A-converter on the connecting board.

4.4.5 Vocoder controller

The vocoder controller takes care of the control of the vocoder and exchanges via the vocoder bus system data and control signals with the various circuits within the vocoder.
Furthermore the vocoder controller looks on transmitting side after the transfer of frames to the comsec controller and on receiving side after the take-over of frames from the comsec controller.
After acceptation of the interrupt signal INTCO, which comes from the comsec controller, the vocoder controller will collect a frame to be sent from the analysis part of the vocoder data memory and transfer this frame to the comsec controller or take over a received frame from the comsec controller, correct its errors, if any, and then store it in the synthesis part of the vocoder data memory.

4.4.6 Vocoder program memory

This program memory (32,768 x 8 bit) contains the firmware for the vocoder controller.

4.4.7 Vocoder data memory

The vocoder data memory consists of a 2048 x 8 bit memory. The vocoder controller uses this memory for the temporary storage of data. Part of the data memory, the analysis part, is used for the storage of frames on the transmitting side. Another part, the synthesis part, is used for the storage of frames on the receiving side.

4.4.8 Vocoder address decoder

This address decoder takes care of the addressing of the various I/O- and memory locations within the vocoder.

4.4.9 Timing circuit

The timing circuit generates several timing signals for the control of the various circuits within the vocoder.

4.4.10 Master clock signal generator

The master clock signal generator produces clock signals of 8192 kHz, 4096 kHz, 2048 kHz and 512 kHz. The clock signals control various circuits within the vocoder. The 4096 kHz clock signal also controls the comsec controller on the controller board and the key generators on the key generator board.

4.5 Analysis board

4.5.1 Segmentation buffer

The A/D-converter on the connecting board presents the in a-law coded 8-bit samples in serial form to the segmentation buffer. In the segmentation buffer a speech segment of 256 samples can be stored. Every 22.5 ms 180 samples are changed and the total contents of the buffer are read out and passed on 128 times parallel to the DFT-processor. During the first transfer to the DFT-processor the speech segment is stored in the speech buffer at the same time.

4.5.2 Pitch buffer

The pitch buffer is an 8-bit buffer for the temporary storage of the pitch.

4.5.3 Speech buffer

In the speech buffer 4 speech segments of 256 samples can be stored and every time the oldest speech segment is overwritten by a new one.

4.5.4 Analysis processor

As soon as a new speech segment has been written into the speech buffer, the analysis processor collects the pitch from the pitch buffer and the LPC-analysis of the oldest speech segment in the speech buffer is started. The results of the LPC-analysis are put in a 54-bit frame. The moment the analysis processor has a new frame ready, the vocoder controller is interrupted (INTAN). After acceptation of the interrupt the vocoder controller will take over the frame and store it in the analysis part of the vocoder data memory on the synthesis board.

4.5.5 Timing circuit

The timing circuit generates several timing signals for the control of the various circuits within the vocoder.

4.5.6 Slave clock signal generator

The slave clock signal generator is controlled by the master clock signal generator on the synthesis board. The slave clock signal generator produces clock signals of 4096 kHz and 2048 kHz. These clock signals control various circuits within the vocoder.

4.6 Key memory board

4.6.1 Program memory 2

Program memory 2 (U EPROM, 32,768 x 8 bit) contains part of the firmware.

4.6.2 Zeroise memory

The zeroise memory (8192 x 8 bit) is used by the comsec controller for the storage of key material.
The zeroise memory is fed with the battery voltage, so that in case of power breakdown its contents remain preserved.
When the ZEROISE push button is pressed or the front panel or upper cover of the equipment is removed, the contents of the zeroise memory will be zeroised.

4.6.3 Key variable memory

The key variable memory (8192 x 8 bit) is destined for the storage of, among other things, the settings of the apparatus.
The key memory is fed with the battery voltage, so that in case of power breakdown its contents remain preserved.

4.6.4 Zeroise circuit

When the ZEROISE push button is pressed or the front panel or the upper cover of the equipment is removed, the zeroise circuit will be activated. The zeroise circuit disconnects the zeroise memory from the battery voltage and the comsec data/control bus, as a result of which the contents of the zeroise memory will be destroyed and the zeroise alarm signal ZERAL will be activated.

4.6.5 Zeroise switch

As soon as the upper cover is removed, the zeroise switch is opened, as a result of which the zeroise circuit will be activated.

4.7 Key generator board

4.7.1 Series/parallel converter transmitting side

The series/parallel converter transmitting side converts the data signal RAOUT coming from the Data Terminal Equipment in parallel form for the comsec controller.

4.7.2 Key generators transmitting side

On the transmitting side the equipment is provided with 2 identical key generators, the Primary Key Generator (PKG) and the Check Key Generator (CKG). The PKG generates key bit series required for the encryption of the data to be transmitted. The CKG generates the same key bit series. By comparing these series the key generators control one another. In case of deviations in the results or a breakdown in one of the key generators, there will be a key generator alarm (AL1 or AL2).

4.7.3 Parallel/series converter transmitting side

The parallel/series converter transmitting side converts the data to be transmitted, which come from the comsec controller, into a serial bit stream of 2400 bit/s.

4.7.4 Series/parallel converter receiving side

The series/parallel converter receiving side converts the received data signal RXD into parallel data for the comsec controller.

4.7.5 Key generator receiving side

This key generator, the Receive Key Generator (RKG), generates the key bit series required for decryption of the received data.

4.7.6 Parallel/series converter receiving side

The parallel/series converter receiving side converts the decrypted data, which come from the comsec controller and are destined for the Data Terminal Equipment, into a serial bit stream of 2400 bit/s.

4.7.7 Alarm circuit

The alarm circuit produces an interrupt signal CRAL (crypto-alarm), as soon as a key generator alarm (AL1 or AL2), a CIK-alarm (CIKAL), a FILL-alarm (FILAL) or a zeroise alarm (ZERAL) occurs. The moment the CRAL-signal becomes high, the signals BLOK1 and BLOK2 are activated,

as a result of which the outgoing and incoming signal channels will be blocked. The signals BLOK1 and BLOK2 are reset again when the equipment goes on hook.

4.8 Controller board

4.8.1 Comsec controller

The comsec controller takes care of the central control of the equipment and exchanges via the comsec bus system data and control signals with the various circuits.

4.8.2 Program memory 1

Program memory 1 (M EPROM, 32,768 x 8 bit) contains part of the firmware.

4.8.3 Data memory red

The data memory red (2048 x 8 bit) is the working memory which is exclusively used by the comsec controller for crypto operations.

4.8.4 Data memory black

The data memory black (2048 x 8 bit) is the working memory which is used by the comsec controller for non-crypto operations. The memory contains temporary auxiliary information, like flags, pointers and the stack.

4.8.5 Address decoder

The address decoder takes care of the addressing of the various I/O- and memory locations within the apparatus.

4.8.6 Interrupt circuit

The interrupt circuit processes all interrupt signals of the various circuits and generates from them the interrupt commands TRAP, RST 7.5, RST 6.5 and RST 5.5 for the comsec controller.

4.9 Timing board

4.9.1 Time base

The time base produces control and clock signals for the various circuits on transmitting and receiving side, viz.:
- a 2400 Hz transmitting clock (TC);
- a 2400 Hz receiving clock (RC);
- the 300 Hz line out interrupt signal (CLOUT);
- the 300 Hz line in interrupt signal (CLIN);
- the 44.44 Hz new frame signal transmitting side (NFTN);
- the 44.44 Hz new frame signal receiving side (NFRN);
- an 8 kHz clock signal transmitting side;
- an 8 kHz clock signal receiving side.

The transmitting clock and the receiving clock have been synchronised with the transmitting clock MOD114 and the receiving clock MOD115 of the modem with the help of Phase Locked Loops (PLLs).

4.9.2 Timers

The timing board is fitted with 2 timers, a timer long and a timer short. The function of these timers is to measure intervals of time. The timers are programmed by the comsec controller and produce an interrupt signal when an interval of time has elapsed.

4.9.3 Alarm and power-on reset circuit

This circuit produces a reset signal (RESET) when there is a breakdown in the comsec controller, when the power supply is switched on and when the power supply voltage becomes too low. The reset signal is directed to the comsec controller and the vocoder controller, which in their turn pass on the signal to several other circuits.

4.10 Telephony board

4.10.1 Dialling tone generator

Via the line output amplifier on the line interface board the dialling tones (TD) are put on the line. Moreover the dialling tones are directed to the telephone amplifier on the connecting board. During the transmission of the dialling tones the microphone signal INTIN is blocked.

4.10.2 Dialling pulse generator

The dialling pulses are put on the line via relays RE2 or RE3 on the line interface board: in 2-wire connection via relay RE2 and in 4-wire connection via relay RE3. During the transmission of dialling pulses on hook relay RE1 of the line interface board is energised.

4.10.3 Answering tone detector

This detector detects the reception of an answering tone of 2025 Hz or 2100 Hz. At the reception of an answering tone the signal ANSWER is activated.

4.10.4 Pre-emption signal detector

This detector passes a received pre-emption signal (420 Hz) on to the telephone amplifier on the connecting board. At the reception of a pre-emption signal the signal PREMPT is also activated.

4.10.5 On/off-hook detector

The on/off-hook detector detects the putting down and the picking up of the handset. When the handset is picked up the signal HOOKSW is low and when it is put down the signal HOOKSW is high. In the latter case also a reset pulse ONH is given to the alarm circuit on the key generator board.

4.10.6 Internal-loop switches

For test purposes the comsec controller can activate the internal-loop switches by means of the DATLP-signal. As a result of this the data signal TXD, which comes from the parallel/series converter on the transmitting side, is connected through to the series/parallel converter on the receiving side.

4.11 V26/V26bis modem

IN EQUIPMENT TYPE UA 8251/00 ONLY

This modem modulates the data to be transmitted and demodulates the received data according to CCITT-recommendation V26/V26bis. The mode of coding (Alternate A or B) is chosen by the comsec controller. By means of the signal SELFTEST the comsec controller can activate the internal self-test of the modem.

4.12 V22bis modem

IN EQUIPMENT TYPE UA 8251/01 ONLY

This modem modulates the data to be transmitted and demodulates the received data according to CCITT-recommendation V22bis. By means of the signal SELFTEST the comsec controller can activate the internal self-test of the modem.

4.13 Line interface board

4.13.1 Line output amplifier

This amplifier amplifies the signal to be transmitted. The signal to be transmitted can be the output signal of the microphone amplifier, the output signal of the dialling tone generator or the output signal of the modem.

4.13.2 Line input amplifier

The line input amplifier amplifies the received signal.

4.13.3 Internal/external modem selector

Under control of the comsec controller the internal/external modem selector brings the internal or external modem into the connection.

4.13.4 Modem interface

The modem interface takes care of the coupling between the equipment and an external modem in accordance with CCITT-recommendation V28.

4.13.5 Ringing signal detector

The ringing signal detector converts a received ringing signal into a signal of 500 Hz. This 500 Hz signal (WEK) is directed to the telephone amplifier on the connecting board. As soon as the handset is picked up (signal HOOKSWN active) the ringing signal is blocked.

4.13.6 Clear/secure relay

The clear/secure relay RE4 is energised, as soon as the comsec controller activates the IM108 signal.

4.13.7 External-loop relay

For test purposes the comsec controller can, by means of the signal MOD141, energise the external-loop relay RE5, as a result of which the (internal) modem output is connected through with the (internal) modem input.

4.13.8 2-wire/4-wire switching relay

When the 2-wire/4-wire switching relay RE6 is energised the equipment is in 2-wire connection, if not, in 4-wire connection. The comsec

controller can energise the relay by activating the signal 2W/4WN.

4.13.9 On-hook relay

The on-hook relay RE1 is energised, when the equipment is in the on-hook state and during transmission of the dialling pulses in the off-hook state.

4.13.10 Dialling pulse relay

The relays RE2 and RE3 are the dialling pulse relays. In 2-wire connection the dialling pulses are put on the line via relay RE2 and in 4-wire connection via relay RE3.

4.14 Cradle/upper cover

In the cradle/upper cover the hook switch has been mounted. As soon as the handset is put down in the cradle, the hook switch is pressed, as a result of which the signal HOOKSW is activated.

4.15 Mains/line filter

4.15.1 Isolating transformers

The mains/line filter is provided with a panel with 2 isolating transformers. These transformers take care of a galvanic separation between the equipment and the line.

4.15.2 Battery

The battery sees to it that in case of a power breakdown and when the power supply is switched off the contents of the zeroise memory and the key variable memory remain preserved.

4.16 Power supply unit

The power supply unit converts the 110/220 V mains supply voltage into the required supply voltages of +5 V, +12 V and -12 V.

5 HARDWARE SETTINGS

This chapter gives a survey of the hardware settings of the equipment. The default (factory) settings have been underlined.

5.1 Front panel

None

5.2 Housing

None

5.3 Connecting board

None

5.4 Synthesis board (see Fig. 5.1)

By means of a jumper on setting block X1 an internal or external 8192 kHz signal can be connected through as master clock signal to synthesis processor 2.

Master clock	Position of jumper
internal 8192 kHz signal	1-2
external 8192 kHz signal	2-3

5.5 Analysis board

None

5.6 Key memory board

None

5.7 Key generator board

None

5.8 Controller board

None

5.9 Timing board (see Fig. 5.2)

By means of a jumper on setting block X2 the line-out interrupt signal CLOUT can be synchronised with a dibit clock signal (1200 Hz) on transmission side coming from the internal modem.

Option	Position of jumper
Do not synchronise	1-2
Synchronise	2-3

5.10 Telephony board

None

5.11 V26/V26bis modem (see Fig. 5.3)

5.11.1 Setting block X2

Jumpers A and B

By means of the jumpers A and B the Request To Send - Clear To Send delay time can be set.

RTS-CTS Delay (ms)	Position of jumpers	
	Jumper A	Jumper B
0 ... 0.035	not inserted	B2-B1
8.55 ... 9.35	A2-A1	not inserted
24.90 ... 26.4	not inserted	not inserted
147.0 ... 154.0	A2-A1	B2-B1

Jumper C

With jumper C it is possible to realise such a setting that the modulator transmits signals at the moment that no data or Answer Back Tones are transmitted.

Option	Position of jumper C
Transmission of signals	C2-C1
No transmission of signals	not inserted

Jumper D

By means of jumper D the bit rate can be set on 1200 bit/s or 2400 bit/s.

Bit rate (bit/s)	Position of jumper D
1200 2400	D2-D1 not inserted

5.11.2 Setting block X3

With jumper 1 and jumper 2 on setting block X3 the Data Clamp Delay can be set on 4 different values.

Data Clamp Delay	Position of jumpers	
	Jumper 1	Jumper 2
6 μs	A1-B1	A2-B2
4.17 ms ± 35 μs	B1-C1	A2-B2
20.83 ms ± 35 μs	A1-B1	B2-C2
104.17 ms ± 35 μs	B1-C1	B2-C2

5.11.3 Setting block X5

With the help of a jumper on setting block X5 it is possible to set the output level of the modem from -12 dB...0 dB in steps of 1.5 dB.

Output level (dB)	Position of jumper
-12.0	1
-10.5	2
-9.0	3
-7.5	4
-6.0	5
-4.5	6
-3.0	7
-1.5	8
0.0	9

Remark: the level of the output modem signal can be accurately adjusted with the help of potentiometer R18 on the line interface board (see § 5.13.5).

5.12 V22bis modem (see Fig. 5.4)

5.12.1 Setting block X2

Jumper 0

By means of jumper 0 the synchronisation mode can be set on synchronous or asynchronous.

Synchronisation mode	Position of jumper
Asynchronous Synchronous	not inserted PE0

Jumper 1

With jumper 1 the bit rate can be set on 600/1200 bit/s or 1200/2400 bit/s.

Bit rate (bit/s)	Position of jumper 1
600/1200 1200/2400	not inserted PE1

Jumper 2

With jumper 2 the V22 mode can be set on V22bis or on V22.

V22 mode	Position of jumper 2
V22bis V22	not inserted PE2

Jumper 3

By means of jumper 3 the communication interface can be set on V22 or Bell.

Communication interface	Position of jumper 3
V22	not inserted
Bell	PE3

Jumper 4

It is not important whether jumper 4 is inserted in position PE4 or not (jumper 4 is not inserted).

Jumpers 5, 6 and 7

With the jumpers 5, 6 and 7 the output level of the modem can be set from -14 dB...0 dB in steps of 2 dB.

Output level (dB)	Position of jumpers		
	Jumper 5	Jumper 6	Jumper 7
-14.0	not inserted	not inserted	not inserted
-12.0	PE5	not inserted	not inserted
-10.0	not inserted	PE6	not inserted
-8.0	PE5	PE6	not inserted
-6.0	not inserted	not inserted	PE7
-4.0	PE5	not inserted	PE7
-2.0	not inserted	PE6	PE7
0.0	PE5	PE6	PE7

Remark: the level of the output modem signal can be accurately adjusted with the help of potentiometer R18 on the line interface board (see § 5.13.5).

5.13 Line interface board (see Fig. 5.5)

5.13.1 Setting block S1

With the help of a jumper on setting block S1 the receiving side of the internal modem can be permanently switched on the line.

Option	Position of jumper
Receiving side modem permanently on line	1-2
Receiving side modem not permanently on line	2-3

5.13.2 Setting block S2

With the aid of a jumper on setting block S2 the MODAB signal can be made permanently high or low. When the jumper is not inserted, the signal is activated by the comsec controller.

Option	Position of jumper
MODAB permanently high	1-2
MODAB permanently low	2-3
Activate MODAB via comsec controller	not inserted

5.13.3 Setting block S3

By means of a jumper on setting block S3 the signal S2100 can be made high or low.

Option	Position of jumper
S2100 high	1-2
S2100 low	2-3

6.3 Set-up test

The equipment knows a test state, in which it is possible to test various hardware circuits. In this test state the following tests can be carried out:
- keyboard/display test
- switch test
- memory test
- modem test
- vocoder test
- timer test
- system test

6.3.1 Test start procedure

To bring the equipment in the test state, first a password must be keyed in. This password is 012345 and is the same for each apparatus. A period of time of 10 seconds is available for keying in the password; after that the apparatus automatically returns to the telephony on-hook substate and "* " appears in the display.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"* "	Apparatus in telephony on-hook substate.
1. Press P key.		"SET UP ?"	
2. Key in password 012345.		"SET UP ?"	The digits do not become visible.
3. Press P key.		"XX ? "	Apparatus in set-up wait state.
4. Key in set-up code 70.		"70 "	
5. Press P key.		"TESTMODE"	Apparatus in test wait state.

The test wait state can be left again by pressing the DTE key or by going off/on hook. By pressing the DTE key the equipment returns to the set-up wait state and "XX ? " appears in the display. By going off/on hook the equipment returns to the telephony on-hook substate and "* " appears in the display.

6.3.2 Keyboard/display test

In the keyboard test substate it is possible to test the keyboard, the display and the dialling tone generator.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 1.		"KBD TEST"	Apparatus in keyboard test substate.
2. Press key 0.		"00000000"	Tone audible.
3. Press key 1.		"11111111"	Tone audible.
4. Press key 2.		"22222222"	Tone audible.
5. Press key 3.		"33333333"	Tone audible.
6. Press key 4.		"44444444"	Tone audible.
7. Press key 5.		"55555555"	Tone audible.
8. Press key 6.		"66666666"	Tone audible.
9. Press key 7.		"77777777"	Tone audible.
10. Press key 8.		"88888888"	Tone audible.
11. Press key 9.		"99999999"	Tone audible.
12. Press * key.		"********"	Tone audible.
13. Press # key.	X	" "	Tone audible.
14. Press DTE key.		"DTE KEY "	
15. Press KDC key.		"KDC KEY "	
16. Press NET key.		"NET KEY "	
17. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Keyboard/display test - fault finding table

Failure	Suspected module
- One or more display characters do not function after the pressing of a certain key.	· Front panel · Connecting board
- One or more display characters do not function continuously.	· Front panel · Connecting board
- The LED does not function.	· Front panel · Connecting board
- No tone is audible after the pressing of a certain key.	· Telephony board
- No tone at all is audible.	· Telephony board · Connecting board · Front panel · Handset

6.3.3 Switch test

In the switch test substate it is possible to test the hook switch, the Ptt-switch and the SECURE push button.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 2.		"H1 P0 S0"	Apparatus in switch test substate.
2. Go off hook.		"H0 P0 S0"	
3. Press Ptt-switch.		"H0 P1 S0"	
4. Release Ptt-switch.		"H0 P0 S0"	
5. Go on hook.		"H1 P0 S0"	
6. Press SECURE push button		"H1 P0 S1"	
7. Release SECURE push button.		"H1 P0 S0"	
8. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Switch test - fault finding table

Failure	Suspected module
- The display indication does not change after going off/on hook.	· Cradle/upper cover · Telephony board
- The display indication does not always change after going off/on hook.	· Cradle/upper cover
- The display indication does not change after pressing/releasing the Ptt-switch.	· Handset · Front panel · Connecting board
- The display indication does not change after pressing/releasing the SECURE push button.	· Front panel · Connecting board

6.3.4 Memory test

In the memory test substate it is possible to test the data memory black, the data memory red, the zeroise memory, the program memory 1 (main-EPROM) and program memory 2 (user-EPROM).

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 3.		"MEM TEST"	Apparatus in memory test substate.
2. Press # key.		"MEM TEST"	Memory is tested.
		"MEM OK "	Memory OK.
3. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Memory test - fault finding table

Display	Meaning	Suspected module
"BLK RAM "	Data memory black faulty	· Controller board
"RED RAM "	Data memory red faulty	· Controller board
"ZER RAM "	Zeroise memory faulty	· Key memory board
"M EPROM "	Program memory 1 faulty	· Controller board
"U EPROM "	Program memory 2 faulty	· Key memory board

5.13.4 Setting block S4

By means of a jumper on setting block S4 the equaliser of the internal modem can be switched permanently on or off. When the jumper is not inserted, the equaliser is switched on or off by the comsec controller.

Option	Position of jumper
Equaliser permanently switched off Equaliser permanently switched on Switch on/off equaliser via comsec controller	1-2 2-3 not inserted

5.13.5 Adjustment of the transmission level

With the aid of the potentiometers R18 and R19 the transmission level can be accurately adjusted. R19 is used for adjusting the level with the internal modem off line (level microphone signal/dialling tones, factory setting -15 dB) and R18 for adjusting the level with the internal modem on line (level modem signal, factory setting -19 dB with equipment type UA 8251/00 and -12 dB with equipment type UA 8251/01).
With potentiometer R11 the hybrid has been adjusted on a minimum value in 2-wire operation.

5.14 Upper cover

None

5.15 Cradle

None

5.16 Mains/line filter

None

5.17 Power supply unit (see Fig. 5.6)

By connecting in a certain way the green and blue wire of the mains transformer to the contact pins of the switch board the power supply can be adjusted at a mains voltage of 110 V or 220 V.

Mains voltage (V)	Connection to switch board	
	Green wire	Blue wire
110	contact pin "D"	contact pin "A"
220	contact pin "B" or "C"	contact pin "C" or "B"

6 FAULT FINDING AND REPAIR PROCEDURES

6.1 General

This chapter gives a full description of the fault finding and repair procedure, which can be performed when a SPENDEX 40 does not function or does not function properly. The described fault finding and repair procedure is restricted to:
- the location of a defective module;
- the replacement of this module;
- the performance of a functional final test.

The location of the defective module can take place on the basis of the fault finding diagram of Fig. 6.1, Fig. 6.2 and Fig. 6.3. In the fault finding procedure laid down in this diagram use is made of, among other things, the failures detected during the initial self-test and the set-up test. The self-test automatically starts after the switching on of the equipment, whereas the set-up test has to be carried out by the operator. The set-up test only makes sense, when no failures have been detected during the self-test.

As soon as a defective module has been located, it must be replaced. Before replacing a module check any possible hardware settings and see to it that the settings on the replacing module correspond to those on the module to be replaced. For detailed demounting and mounting instructions see chapter 7.

After one or more modules have been replaced, a functional final test should be carried out to check whether the equipment does function properly again. This functional final test consists of the carrying out again of the self-test and the set-up test.

6.2 Self-test

After being switched on the equipment starts an initiation procedure followed by an automatic self-test. During this self-test various circuits are tested on their faultless functioning, viz.
- program memory 1 (main-EPROM)
- program memory 2 (user-EPROM)
- the data memory black
- the data memory red
- the zeroise memory
- the interrupt circuit
- the time base
- timer long and timer short
- the key generators (PKG, CKG and RKG)
- the modem

If no errors are detected "* " appears in the display after some seconds and the equipment is ready for operation. If an error is found, this will result in a fatal or non-fatal hardware alarm. An error will result in a fatal hardware alarm when as a consequence of

this the equipment can no longer be used in both the secure and the nonsecure mode, and in a non-fatal alarm when the equipment can still only be used in the nonsecure mode.

A fatal hardware alarm results in unconditional changeover to the alarm state. An alarm appears in the display, the self-test stops, the LED starts to flash and an alarm signal becomes audible.
A non-fatal hardware alarm results in a display report of some seconds. After that the self-test will be continued. When further no fatal hardware errors are detected, finally "* " appears in the display and it will only be possible to use the apparatus for nonsecure communication.

During the self-test also the internal or external modem will be tested. Which modem will be tested depends on the Low/High Frequency setting. If the equipment is set on Low Frequency (LF), the internal modem will be automatically tested. Is it set on High Frequency (HF), the external modem will be tested.
For a successful course of the test of the internal modem the 2-wire/4-wire and the Half/Full Duplex settings are important. Equipment type UA 8251/01 should be set on 2-wire Full Duplex (2WFD). With equipment type UA 8251/00 all setting possibilities are allowed, except 2-wire Full Duplex.

On the basis of the following fault finding tables the cause of a hardware alarm detected during the self-test can be located. First try to stop the alarm by switching off the equipment and then switching it on again.

6.2.1 Fatal hardware alarms - fault finding table

Display	Meaning	Suspected module
"%BLK RAM"	Data memory black faulty	· Controller board
"%INT --1"	Timer short interrupt cannot be reset	· Controller board
"%INT --2"	Timer long interrupt cannot be reset	· Controller board
"%INT --4"	Keyboard interrupt cannot be reset	· Controller board
"%INT -1-"	Modem interrupt cannot be reset	· Controller board
"%INT -2-"	Vocoder interrupt cannot be reset	· Controller board
"%INT -4-"	Time base interrupt cannot be reset	· Controller board
"%INT 1--"	Bubble interrupt cannot be reset	· Controller board
"%INT 2--"	Line-in interrupt cannot be reset	· Controller board
"%INT 4--"	Line-out interrupt cannot be reset	· Controller board
"%INT 1"	RST 5.5 interrupt cannot be reset	· Controller board
"%INT 2"	RST 6.5 interrupt cannot be reset	· Controller board
"%M EPROM"	Main-EPROM faulty	· Controller board
"%RED RAM"	Data memory red faulty	· Controller board
"%TIBASE "	Time base alarm	· Timing board
"%TMLONG "	Timer long faulty	· Timing board
"%TMSHRT "	Timer short faulty	· Timing board
"%U EPROM"	User-EPROM faulty	· Key memory board

6.2.2 Non-fatal hardware alarms - fault finding table

Display	Meaning	Suspected module
"%ACTV -1"	Activity alarm PKG cannot be reset	· Key generator board
"%ACTV -2"	Activity alarm CKG cannot be reset	· Key generator board
"%ACTV -4"	Activity alarm RKG cannot be reset	· Key generator board
"%COMAL -"	Compare alarm cannot be reset	· Key generator board
"%CRYP AL"	Crypto alarm cannot be reset	· Controller board
"%KGR "	RKG cannot be switched over to firmware clock	· Key generator board
"%KGR 1"	Key bit alarm RKG	· Key generator board
"%KGR 2"	Subkey bit alarm RKG	· Key generator board
"%KGR 4"	Parity bit alarm RKG	· Key generator board
"%KGT "	PKG/CKG cannot be switched over to firmware clock	· Key generator board
"%KGT 1"	Key bit alarm PKG/CKG	· Key generator board
"%KGT 2"	Subkey bit alarm PKG/CKG	· Key generator board
"%KGT 4"	Parity bit alarm PKG/CKG	· Key generator board
"%LOOP 1"	Internal (digital) loop faulty	· Telephony board · Key generator board · Timing board
"%LOOP 3"	External (analogue) loop faulty	· Telephony board · Line interface board · Modem · Key generator board
"%LOOT -1"	Random bit alarm PKG cannot be set/reset	· Key generator board

Non-fatal hardware alarms - fault finding table (continued)

Display	Meaning	Suspected module
"%LOOT -2"	Random bit alarm CKG cannot be set/reset	· Key generator board
"%LOOT -4"	Random bit alarm RKG cannot be set/reset	· Key generator board
"%MODEM "	Modem control signals or settings of the equipment incorrect	FIRST CHECK THE SETTINGS OF THE EQUIPMENT!!! · Telephony board · Line interface board · Modem
"%ZER RAM"	Zeroise memory faulty	· Key memory board

6.3.5 Modem test

In the modem test substate it is possible to test the internal and the external modem. Which modem will be tested depends on the Low/High Frequency setting. If the equipment is set on Low Frequency (LF), the internal modem will be automatically tested. Is it set on High Frequency (HF), the external modem will be tested.
For a successful course of the internal modem test the 2-wire/4-wire and the Half/Full Duplex settings are important. Equipment type UA 8251/01 should be set on 2-wire Full Duplex (2WFD). With equipment type UA 8251/00 all setting possibilities are allowed, except 2-wire Full Duplex.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 4.		"MOD TEST"	Apparatus in modem test substate.
2. Press # key.		"MOD TEST"	Modem is tested.
		"MODEM OK"	Modem OK.
3. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Modem test - fault finding table

Display	Meaning	Suspected module
"MODM ccc"	Control signals of modem or settings of apparatus incorrect (ccc = 001...008, 016, 024, 032, 064, or 128).	FIRST CHECK THE SETTINGS OF THE EQUIPMENT!! · Telephony board · Line interface board · Modem
"MDERR 01"	External loop faulty	· Telephony board · Line interface board · Modem · Key generator board
"MDERR 02"	Internal loop faulty	· Telephony board · Key generator board · Timing board

6.3.6 Vocoder test

In the vocoder test substate it is possible to test the vocoder.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 5.		"VOC TEST"	Apparatus in vocoder test substate.
2. Go off hook.		"VOC TEST"	
3. Press # key.		"SPEAK ! "	The vocoder is looped.
4. Speak into the microphone.		"SPEAK ! "	The speech must be audible in the telephone.
5. Go on hook.		"%VOCOM "	
6. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Vocoder test - fault finding table

Failure	Suspected module
- No sound audible in the telephone.	· Handset · Connecting board · Analysis board · Synthesis board
- No speech recognisable.	· Analysis board · Synthesis board · Connecting board · Handset

6.3.7 Timer test

In the timer test substate it is possible to test timer short, timer long and the software timer.

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Key in test code 6.		"TIM TEST"	Apparatus in timer test substate.
2. Press key 1.		"TMSH xx"	Timer short is tested. It functions as a seconds counter.
3. Press key 2.		"TMLO yy"	Timer long is tested.
4. Press key 3.		"TMSW xx"	The software timer is tested. It functions as a seconds counter.
5. Press P key.		"TESTMODE"	Apparatus back to test wait state.
xx = counter reading (counter must run from 00 to 59 in exactly 1 minute). yy = counter reading (counter must run from 00 to 59 in approx. 65 seconds).			

Timer test - fault finding table

Failure	Suspected module
- During the testing of 1 or more timers the counter reading in the display changes too fast or does not change at all.	· Timing board

6.3.8 System test

In the system test substate it is possible to test the system completely. The system test can only be carried out with the equipment type UA 8251/00. For a successful course of the test, the equipment must be set on Low Frequency (LF).

Actions	LED	Display	Remarks
Start conditions: - Apparatus on hook		"TESTMODE"	Apparatus in test wait state.
1. Make a system loop by inserting the loop-back connector into the line connector. See note 1.		"TESTMODE"	
2. Key in test code 7.		"VOC TEST"	Apparatus in system test substate.
3. Go off hook.		"VOC TEST"	
4. Press # key.	X	"SPEAK ! "	The system is looped.
5. Speak into the microphone.	X	"SPEAK ! "	The speech must be audible in the telephone.
6. Go on hook.		"%VOCOM "	
7. Press P key.		"TESTMODE"	Apparatus back to test wait state.

Note 1: The loop-back connector connects pin 1 of the line connector with pin 3 and pin 2 with pin 4. If this loop-back connector is not available, the system loop can also be achieved by connecting pin "a" of the telephone connector with pin "EB" and pin "b" with pin "GND".

System test - fault finding table

Failure	Suspected module
- No sound audible in the telephone.	FIRST CHECK THE LOW/HIGH FREQUENCY SETTING!! · Handset · Front panel · Connecting board · Analysis board · Synthesis board · Key generator board · Telephony board · Line interface board · Modem · Mains/line filter
- No speech recognisable.	· Handset · Front panel · Connecting board · Analysis board · Synthesis board · Key generator board · Telephony board · Line interface board · Modem · Mains/line filter

7 DEMOUNTING AND MOUNTING

7.1 General

In this chapter instructions are given for the mounting and demounting of the exchangeable units.

The following boards are mounted on each other by means of distant pieces:
- line interface board and modem
- synthesis board and analysis board
- key generator board and controller board
- timing board and telephony board

The connecting board is mounted in the red compartment of the housing and can be reached after removal of the front panel.
The line interface board/modem assembly is mounted in the line interface compartment of the housing and can be reached after removal of the mains/line filter.
The key memory board and the assemblies synthesis board/analysis board, key generator board/controller board and timing board/telephony board are found in the red compartment and can be reached after removal of the cradle and the upper cover.
The power supply unit is mounted in the power supply compartment of the housing.

7.2 Replacement of the battery

The battery is placed in the mains/line filter. The battery need only be replaced every other year.

- Loosen the 4 captive M3 socket head screws, with which the battery cover is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the battery cover;
- Take the battery out of the clamp with the help of the pull strip;
- Place the new battery together with the pull strip between the clamps. Pay attention to the polarity;
- Replace the battery cover and screw down again the 4 socket head screws;
- Mention the new replacement date of the battery on the text plate of the battery cover.

7.3 Demounting

7.3.1 Demounting of the front panel

- Remove the USFA-sealing strip. This strip is found on the bottom side of the apparatus on the dividing line of front panel and housing;

- Loosen the 12 captive M4 socket head screws, with which the front panel is fixed to the housing. Use for this purpose a round head screwdriver, size 3;
- Take the front panel from the housing without damaging the packing. The packing should remain in the front panel;

> ATTENTION!!
>
> AS SOON AS THE FRONT PANEL IS TAKEN FROM THE HOUSING THE ZEROISE SWITCH ON THE CONNECTING BOARD WILL BE OPENED, AS A RESULT OF WHICH ANY POSSIBLE KEY VARIABLES ARE ZEROISED IMMEDIATELY.

- Release the flat cable connectors X32, X28, X26, X24 and X22 carefully (see Fig. 7.1);
- Detach the earth wire from the mother board.

7.3.2 Demounting of the connecting board

- Demount the front panel as described in § 7.3.1;
- Loosen the 8 M3 socket head screws, with which the connecting board is fixed in the housing. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Pull the connecting board carefully loose from connector X2 of the mother board and take the board out of the housing.

7.3.3 Demounting of the mains/line filter (back cover)

- Loosen the 14 captive M4 socket head screws, with which the mains/line filter is fixed to the housing. Use for this purpose a round head screwdriver, size 3;
- Take the mains/line filter from the housing without damaging the packing. The packing should remain in the housing;
- Release the flat cable connector X56 and the blue connectors X53, X57, X59 and X61 carefully (see Fig. 7.2);
- Loosen the 2 M2.5 screws, with which connector X76 is fixed to the bottom of the power supply compartment;
- Remove the screws and loosen connector X76.

7.3.4 Demounting of the line interface board

The line interface board and the modem make up an assembly. The whole is mounted in the line interface compartment of the housing.

- Demount the mains/line filter as described in § 7.3.3;
- Release the flat cable connectors X50 and X52 and the blue connector X63 carefully (see Fig. 7.2);

- Loosen the 6 captive M4 socket head screws, with which the line interface board/modem assembly is fixed in the housing. Use for this purpose a round head screwdriver, size 3;
- Take the line interface board/modem assembly carefully out of the housing. See to it that the flat cable connectors X50 and X52 are not damaged;
- Screw the 6 captive M4 socket head screws out of the distant pieces of the assembly;
- Loosen the 6 M3 screws, with which the line interface board is fixed;
- Remove the 6 M3 screws, including the plain washers and the retaining Belleville washers;
- Pull the line interface board carefully out of the connector X48 of the modem.

7.3.5 Demounting of the modem

The modem and the line interface board make up an assembly. The whole is mounted in the line interface compartment of the housing.

- Demount the mains/line filter as described in § 7.3.3;
- Release the flat cable connectors X50 and X52 and the blue connector X63 carefully (see Fig. 7.2);
- Loosen the 6 captive M4 socket head screws, with which the line interface board/modem assembly is fixed in the housing. Use for this purpose a round head screwdriver, size 3;
- Take the line interface board/modem assembly carefully out of the housing. See to it that the flat cable connectors X50 and X52 are not damaged;
- Loosen the 6 M3 screws, with which the modem is fixed;
- Remove the 6 M3 screws, including the plain washers and the retaining Belleville washers;
- Take away the modem.

7.3.6 Demounting of the cradle

- Loosen the 3 M5 socket head screws, with which the cradle is fixed on the housing. Use for this purpose a round head screwdriver, size 4;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take the cradle from the housing.

7.3.7 Demounting of the upper cover

- Demount the cradle as described in § 7.3.6;
- Remove the 2 USFA-sealing strips;
- Loosen the 14 captive M4 socket head screws, with which the upper cover is fixed on the housing. Use for this purpose a round head screwdriver, size 3;
- Take the upper cover from the housing without damaging the packing.

The packing should remain in the housing;

> ATTENTION!!
>
> AS SOON AS THE UPPER COVER IS TAKEN FROM THE HOUSING THE ZEROISE SWITCH ON THE KEY MEMORY BOARD WILL BE OPENED, AS A RESULT OF WHICH ANY POSSIBLE KEY VARIABLES ARE ZEROISED IMMEDIATELY.

- Release the connections with the hook switch.

7.3.8 Demounting of the synthesis board

The synthesis board and the analysis board make up an assembly. The whole is mounted in the red compartment of the housing on position 1/2.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the synthesis board/analysis board assembly loose from the connectors X3 and X5 of the mother board and take the whole out of the housing;
- Loosen the 5 M3 socket head screws, with which the synthesis board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the synthesis board.

7.3.9 Demounting of the analysis board

The analysis board and the synthesis board make up an assembly. The whole is mounted in the red compartment of the housing on position 1/2.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the synthesis board/analysis board assembly loose from the connectors X3 and X5 of the mother board and take the whole out of the housing;
- Loosen the 5 M3 socket head screws, with which the analysis board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the analysis board.

7.3.10 Demounting of the key memory board

The key memory board is found in the red compartment of the housing on position 3.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the key memory board loose from connector X7 of the mother board and take the board out of the housing.

7.3.11 Demounting of the key generator board

The key generator board and the controller board make up an assembly. The whole is mounted in the red compartment of the housing on position 4/5.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the key generator board/controller board assembly loose from the connectors X9 and X11 of the mother board and take the whole out of the housing;
- Loosen the 5 M3 socket head screws, with which the key generator board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the key generator board.

7.3.12 Demounting of the controller board

The controller board and the key generator board make up an assembly. The whole is mounted in the red compartment of the housing on position 4/5.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the key generator board/controller board assembly loose from the connectors X9 and X11 of the mother board and take the whole out of the housing;
- Loosen the 5 M3 socket head screws, with which the controller board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the controller board.

7.3.13 Demounting of the timing board

The timing board and the telephony board make up an assembly. The whole is mounted in the red compartment of the housing on position 6/7.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the timing board/telephony board assembly loose from the connectors X13 and X15 of the mother board and take the whole out

of the housing;
- Loosen the 5 M3 socket head screws, with which the timing board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the timing board.

7.3.14 Demounting of the telephony board

The telephony board and the timing board make up an assembly. The whole is mounted in the red compartment of the housing on position 6/7.

- Demount the cradle as described in § 7.3.6;
- Demount the upper cover as described in § 7.3.7;
- Pull the timing board/telephony board assembly loose from the connectors X13 and X15 of the mother board and take the whole out of the housing;
- Loosen the 5 M3 socket head screws, with which the telephony board is fixed. Use for this purpose a round head screwdriver, size 2.5;
- Remove the socket head screws, including the plain washers and the retaining Belleville washers;
- Take away the telephony board.

7.3.15 Demounting of the power supply unit

- Loosen the 12 captive M4 socket head screws, with which the power supply unit is fixed in the housing. Use for this purpose a round head screwdriver, size 3;
- Take the power supply unit out of the apparatus without damaging the packing. The packing should remain in the housing;
- Loosen the 4 M2.5 screws, with which the connectors X70 and X71 are fixed on the bottom of the power supply compartment (see Fig. 7.3);
- Remove the screws, including the mounting strip and release the connectors X70 and X71.

7.4 Mounting

7.4.1 Mounting of the front panel

- Connect the earth wire to the second pin to the left at the bottom of the mother board (see Fig. 7.1);
- Connect the flat cable connectors X32, X28, X26, X24 and X22 to the connecting board;
- Place the front panel against the housing. See to it that the various connections with the connecting board do not get jammed;
- Tighten the 12 captive socket head screws;
- Affix a new USFA-sealing strip.

7.4.2 Mounting of the connecting board

- Press the connecting board carefully into connector X2 of the mother board;
- Apply the 8 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws.

7.4.3 Mounting of the mains/line filter (back cover)

- Connect connector X76 to connector X75, which is fixed on the bottom of the power supply compartment (see Fig. 7.2);
- Fix connector X76 with the appropriate M2.5 screws;
- Connect the flat cable connector X56 and the blue connectors X53, X57, X59 and X61 to the line interface board;
- Place the mains/line filter against the back of the housing. See to it that the various connections with the line interface board do not get jammed;
- Tighten the 14 captive M4 socket head screws.

7.4.4 Mounting of the line interface board

- Check the hardware settings of the line interface board. Change them, if necessary;
- Press the line interface board carefully on connector X48 of the modem;
- Apply the 6 M3 screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the screws;
- Screw the 6 captive M4 socket head screws in the appropriate holes in the distant pieces;
- Place the line interface board/modem assembly carefully into the housing. See to it that the flat cable connectors X50 and X52 are not damaged;
- Tighten the 6 captive M4 socket head screws;
- Connect the flat cable connectors X50 and X52 and the blue connector X63 to the line interface board (see Fig. 7.2).

7.4.5 Mounting of the modem

- Check the hardware settings of the modem. Change them, if necessary;
- Press the modem carefully on connector X47 of the line interface board;
- Apply the 6 M3 screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the screws;
- Place the line interface board/modem assembly carefully into the housing. See to it that the flat cable connectors X50 and X52 are not damaged;

- Tighten the 6 captive M4 socket head screws;
- Connect the flat cable connectors X50 and X52 and the blue connector X63 to the line interface board (see Fig. 7.2).

7.4.6 Mounting of the cradle

- Place the cradle on the housing;
- Apply the 3 M5 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws.

7.4.7 Mounting of the upper cover

- Connect the hook switch;
- Place the upper cover on the housing. See to it that the connections with the hook switch do not get jammed;
- Tighten the 14 captive M4 socket head screws;
- Affix 2 new USFA-sealing strips.

7.4.8 Mounting of the synthesis board

- Check the hardware settings of the synthesis board. Change them, if necessary;
- Place the synthesis board on the distant pieces mounted on the analysis board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the synthesis board/analysis board assembly into the housing on position 1/2 and press it into the connectors X3 and X5 of the mother board.

7.4.9 Mounting of the analysis board

- Place the analysis board on the distant pieces mounted on the synthesis board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the synthesis board/analysis board assembly into the housing on position 1/2 and press it into the connectors X3 and X5 of the mother board.

7.4.10 Mounting of the key memory board

- Place the key memory board into the housing on position 3 and press it into the connector X7 of the mother board.

7.4.11 Mounting of the key generator board

- Place the key generator board on the distant pieces mounted on the controller board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the key generator board/controller board assembly into the housing on position 4/5 and press it into the connectors X9 and X11 of the mother board.

7.4.12 Mounting of the controller board

- Place the controller board on the distant pieces mounted on the key generator board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the key generator board/controller board assembly into the housing on position 4/5 and press it into the connectors X9 and X11 of the mother board.

7.4.13 Mounting of the timing board

- Check the hardware settings of the timing board. Change them, if necessary;
- Place the timing board on the distant pieces mounted on the telephony board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the timing board/telephony board assembly into the housing on position 6/7 and press it into the connectors X13 and X15 of the mother board.

7.4.14 Mounting of the telephony board

- Place the telephony board on the distant pieces mounted on the timing board;
- Apply the 5 M3 socket head screws, including the plain washers and the retaining Belleville washers to the appropriate places;
- Tighten the socket head screws;
- Place the timing board/telephony board assembly into the housing on position 6/7 and press it into the connectors X13 and X15 of the mother board.

7.4.15 Mounting of the power supply unit

- Check the mains voltage setting. Change it, if necessary;
- Connect the connectors X70 to X69 and X71 to X72. The connectors

X69 and X72 are fixed on the bottom of the power supply compartment (see Fig. 7.3);
- Place the mounting strip and fix the connectors with the appropriate M2.5 screws;
- Put the power supply unit into the apparatus. See to it that the various connections do not get jammed;
- Tighten the 12 captive M4 socket head screws.

7.5 Adjustment of the transmission level

With the potentiometers R18 and R19 on the line interface board the transmission level can be accurately adjusted. R19 is used for adjusting the level with the internal modem off line (microphone signal/dialling tones level, factory setting -15 dB) and R18 for adjusting the level with the internal modem on line (modem signal level, factory setting -19 dB with equipment type UA 8251/00 and -12 dB with equipment type UA 8251/01). The limits within which the modem signal level can be adjusted depends on the transmission level setting of the modem.

7.5.1 Adjustment of the microphone signal/dialling tones level

- Loosen the 14 captive M4 socket head screws, with which the mains/line filter is fixed in the apparatus;
- Take the mains/line filter carefully out of the apparatus. See to it that the connections with the line interface board do not come loose;
- Switch on the equipment and wait until "* " appears in the display;
- Set the equipment on Tone Dialling, Low Frequency, 4-wire and Full Duplex (TDLF4WFD);
- Bring the apparatus in the test state. The display shows "TESTMODE";
- Connect the line connecting cable and insert a resistor of 600 Ω between the pins "EB" and "GND" of the telephone connector;
- Key in test code 1. The display shows "KBD TEST";
- Press key 2. The display shows "22222222" and a tone is audible;
- Go off hook;
- Connect the pins "EB" (+) and "GND" (-) of the telephone connector to a multimeter and adjust the desired level value with potentiometer R19;
- Press P key. The display shows "TESTMODE";
- Go on/off hook. The display shows "* ";
- Switch off the equipment;
- Replace the mains/line filter into the apparatus. See to it that the connections with the line interface board do not get jammed. Then tighten again the 14 captive socket head screws.

7.5.2 Adjustment of the modem signal level

- Loosen the 14 captive M4 socket head screws, with which the

mains/line filter is fixed in the apparatus;
- Take the mains/line filter carefully out of the apparatus. See to it that the connections with the line interface board do not come loose;
- Switch on the equipment and wait until "* " appears in the display;
- Bring the equipment in the test state. The display shows "TESTMODE";
- Connect the line connecting cable and connect on the telephone connector pin "a" with pin "EB" and pin "b" with pin "GND";
- Key in test code 7. The display shows "VOC TEST";
- Go off hook;
- Press the # key. The LED lights up and in the display "SPEAK ! " appears;
- Connect the pins "EB" (+) and "GND" (-) of the telephone connector to a multimeter and adjust the desired level value with potentiometer R18;
- Go on hook. The display shows "%VOCOM ";
- Press P key. The display shows "TESTMODE";
- Go on/off hook. The display shows "* ";
- Switch off the equipment;
- Replace the mains/line filter into the apparatus. See to it that the connections with the line interface board do not get jammed. Then tighten again the 14 captive socket head screws.