Service Manual



Pye Telecommunications Ltd

Mobile Control Panel
Type CX290

(For E31–300 Applications)

Publication Ref. No. TP223

This Service Manual is for the maintenance of Pye Telecommunications equipment. The performance figures quoted are typical and are subject to normal manufacturing and service tolerances.

The right is reserved to alter the equipment described in this manual in the light of future technical development.

MOBILE CONTROL PANEL
TYPE CX290

(For E31–300 Applications)

SERVICE MANUAL
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TP223

AMENDMENT LIST

Changes made to the equipment described in this manual are published as amendments which are dated and consecutively numbered.

Reprints of the manual will incorporate all the amendments to date and an entry to this effect will be recorded on the amendment list below. Each page affected by amendment action will bear the amendment number as a suffix to the manual reference number e.g. TP123/4 indicates that the page has been corrected by amendment number 4.

Should it be necessary to raise the issue of a manual the amendment numbering will recommence with No. 1.

Amend't No.	Date	Initials	Remarks
1	May 1985	—	Incorporated in reprint

ERRORS & OMISSIONS

The usefulness of this Service Manual depends upon its accuracy. Whilst every endeavour has been made to minimise errors, some may exist. It is therefore requested that any errors or omissions noted be advised as follows:

Please quote:

a) Title of manual

b) TP No. and Issue No.

c) Last amendment No. received

d) Page and/or Fig. No. in error

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SECTION 1
GENERAL INFORMATION

SUMMARY OF DATA

Supply Voltage	13,8V DC nominal (11V to 16V).
Current Consumption	CX290: Typically 300 mA at 13,8V CX290 + MX290: Typically 850 mA at 13,8V on receive.
Tone Signalling Format	EEA 9 tone sequential
Tone Length	40 mS.
Tone Frequency Range	See Table 1.1
Input Level	Level to freetone detector adjustable on CX290. All other levels adjustable on MX290.
Maximum Output Level	Sequential tone output 250 mV at less than 5% distortion.
Link Establishment Time (LET)	Linkable to 150 mS, 250 mS or 350 mS.
Operating Temperature Range	-30°C to +60°C
Program Storage	4k EPROM 2k x 4 bit personality PROM
Dimensions	175 mm (6⅞in.) wide; 205 mm (8⅛in.) deep; 52 mm (2⅛in.) high.
Controls	On/Off (I/O) Keypad: 0 - 9 Volume (VOL) Clear (CL) Terminate Call (#) Send/Answer (*) Local Communciation (□)
Indicators	Power On Local Communication Channel Selected Transmitter On Call Received Busy Out of Range

Digit	Frequency (Hz)
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
O	1981
A	1055
B	930
E (Repeat)	2110

Table 1.1



INTRODUCTION

The E31 – 300 mobile radiotelephone is a simplex multichannel synthesised, microprocessor controlled unit comprising a systems version of an MX290 series radiotelephone (fitted with a carrier level detector board)and a CX290 control head.

All functions within the unit are under the control of the microprocessor. Signalling protocol to and from the control system is determined by the processor software, as is channel selection and control of the numerical display. The mobile user controls the unit by means of the front panel illuminated push-buttons and volume control, and by the fist microphone pressel. A loudspeaker is supplied through which both speech and tone signals are reproduced.

Special maintenance software is available to enable the service technician to directly access the radio facilities from the control keyboard. The software shows incoming signalling on the numerical display, monitors internal functions and displays error messages.

Facilities provided by the equipment are as follows:

(i) Scanning of channels and monitoring each for signal strength and presence of tones.

(ii) Generation and detection of sequential tones for selective signalling.

(iii) Keypad digits entered on keypad are displayed on the front panel.

(iv) Selection of receiver audio or locally generated tones for routing to the loudspeaker.

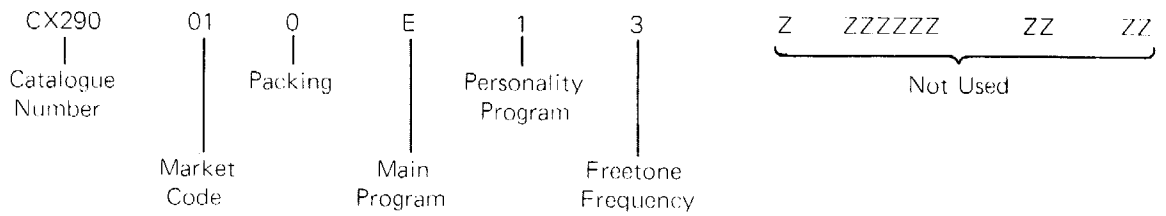
A single frequency simplex channel may be used to page a mobile user absent from a vehicle and for direct shortrange communication between two mobile units.

This service manual gives details of the CX290 control head and its interconnections with the MX290. Full details of the radiotelephone are given in the relevant MX290 series service manual.

OPTIONS

The sub-assemblies fitted to an equipment will vary according to the role in which it is used, the complement of sub-assemblies for any particular equipment is indicated by a code number shown on the equipment label (together with catalogue and serial numbers) attached to the unit.

A typical equipment label is shown below:



Note: For options 'Not Used' insert digits shown.

Market Code

01 Standard Production

Packing

0 Fitted to equipment
1 Supplied as discrete unit

Main Program

E E31 - 300

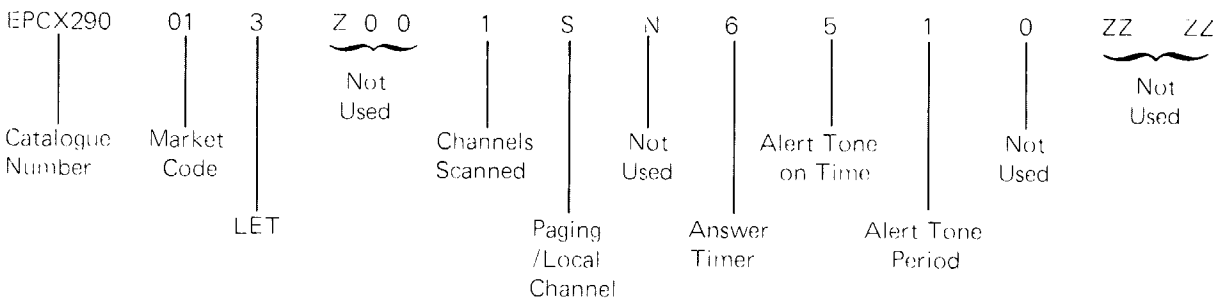
Personality Program

1 Programming Options EP CX290

Freetone Frequency

1	529 Hz	7	770 Hz
2	563 Hz	8	820 Hz
3	600 Hz	9	873 Hz
4	638 Hz		
5	679 Hz		
6	723 Hz		

Similarly, software options are selected from the following:



Note: For options 'Not Used' insert digits shown.

Market Code

01 Standard Production

Link Establishment Time (LET)

3 150 mS
4 250 mS
5 350 mS

Channel Scanned

1-8 Number of Channels Scanned.

Paging/Local Channel

O	Less option
S	With Paging and Local Communication
L	With Local Communication Only
P	With Paging Only

Answer Timer

1	5 seconds	A	50 seconds
2	10 seconds	B	55 seconds
3	15 seconds	C	60 seconds
4	20 seconds	D	65 seconds
5	25 seconds	E	70 seconds
6	30 seconds	F	75 seconds
7	35 seconds		
8	40 seconds		
9	45 seconds		

Note: Normal setting between 20 and 35 seconds

Alert Tone On Time

1	100 mS	6	600 mS
2	200 mS	7	700 mS
3	300 mS	8	800 mS
4	400 mS	9	900 mS
5	500 mS	A	1 second

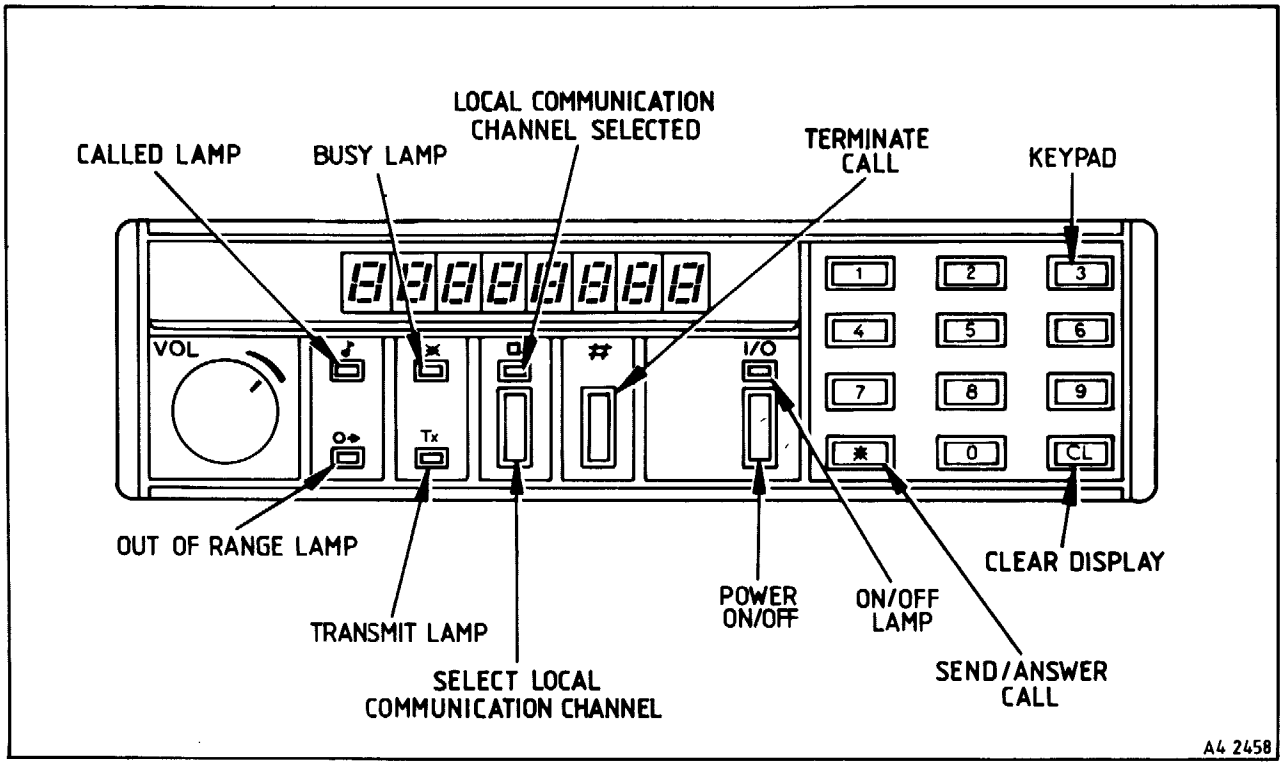
Note: Normal setting 1 second

Alert Tone Period

1	1 second	A	10 seconds
2	2 seconds	B	11 seconds
3	3 seconds	C	12 seconds
4	4 seconds	D	13 seconds
5	5 seconds	E	14 seconds
6	6 seconds	F	15 seconds
7	7 seconds		
8	8 seconds		
9	9 seconds		

Note: Normal setting 5 seconds

SECTION 2
OPERATION



CONTROLS

All controls, with the exception of the press-to-transmit switch on the fist microphone are located on the front panel of the equipment.

The controls are as follows

I/O — Push button switch with latching action which makes or breaks the power supply to the equipment

VOL ↖ — Volume control

— Terminate Call button – terminates a conversation and resets equipment

□ — Local Communication button – switches to the local simplex channel (if fitted).

Keypad

0-9 — For entering the required telephone or mobile users number into the dial digit store. The number entered is verified on the display.

CL — Clear button – clears display when incorrect number has been entered.

***** — Send/Answer button – initiates an outgoing call; answers an incoming call.

INDICATORS

I/O Equipment switched on

□ Local communication channel selected

Tx Mobile transmitting

♪ Call received

✱ No free channel (system busy)

⊙→ Out of range of base station.

Eight digit display indicates selected channel and provides verification of keypad entry.

PROCEDURE

Switching On

Press the **I/O** switch and check that the power on lamp is lit.

The equipment will indicate one of the following conditions:

(i) If the mobile is within range of its own E31–300 system with one or more free channels (i e: not busy) the display will indicate the free radio channel selected for communication by the mobile equipment.

Note: When more than one free channel is available the equipment selects the channel with the strongest received signal.

(ii) If all channels of the E31–300 system received by the mobile are in use the busy (✱) lamp is lit.

(iii) If no channel (busy or free) can be found the mobile equipment is deemed 'out of-range' and the ⊙→ lamp is lit.

Initiating a Call

Note: A group call cannot be initiated by a mobile user.

1. (a) To call a mobile – Press digit '3' on the keypad followed by the identity of the mobile.

   (b) To call a telephone subscriber – Press digit '4' on the keypad followed by the telephone number.

   If an error is made press 'CL' on the keypad to clear the display, then start again.

2. Press the send button to transmit the digits. After a pause one of the following tones will be heard:

   (i) Ringing tone

   (ii) Engaged tone

   (iii) Number Unobtainable tone (NU tone)

   If the number is engaged or unobtainable press the terminate call button then start again.

3. When the 'called' party answers conversation may take place.
   The mobile operator uses normal simplex radiotelephone procedure.

The call period limit is defined by the user (eg: 10 mins) – a warning tone will sound 30 seconds before the end of the time limit. Conversation may also be terminated during this period by manual operation of the terminate call button.

Receiving an Individual Call

1. On receipt of the call the display becomes blank and an interrupted alert tone sounds.

2. Press the answer button to accept the call. Converse in the normal manner using radiotelephone procedure.

3. Failure to accept the call within the alert tone period means:

   (i) If the call was from another mobile the base station equipment will cleardown both mobiles.

   or (ii) If the call was from a telephone subscriber, the caller may select the call-back facility. If this facility is not used the base station equipment will cleardown the mobile.

4. The called lamp will indicate that the call-back facility has been used and will remain lit until the call is answered.

5. To 'call-back' the telephone subscriber press digit '5' on the keypad followed by the send button; the called lamp will go out.

   If the number is engaged or the call not answered the call can be stored again by pressing digit '6' on the keypad followed by the send button.

   The call can be made again by pressing digit '5' followed by the send button and if necessary stored again by pressing digit '6' followed by the send button.

   This procedure can be repeated as often as necessary during the 'call-back' period.

   Note: The call back timer does not reset if the telephone number is stored again; the called lamp is lit again.

6. To terminate a 'call-back' conversation the terminate call button is operated as normal.

Receiving a Group Call

1. On receipt of a group call the display becomes blank and a two tone alert sounds. Conversation may take place on completion of the alert tones.

2. Operation of the terminate call button during the call will cleardown an individual mobile. The equipment will automatically cleardown on completion of the group call.

Conference Call

A conference call facility is available which enables the telephone subscriber to call up to four mobile radio users allowing conversation to take place between all parties.

Mobile operator action is the same as for receiving an individual call. A mobile operator may withdraw from the 'conference' by operating the terminate call button as normal. The last mobile user to withdraw terminates the radio connection. The call is also terminated when the telephone subscriber replaces the handset.

Pager Call (If fitted)

If the mobile is unattended and the user carries a pager, selection of the call-back facility by a telephone subscriber will cause the called lamp to light as normal, but will, additionally, switch the mobile to the single frequency simplex channel transmit a 'selcall' message to the pager to alert the user then switch the mobile back to the main system. The user can respond in the normal manner.

Local Communication (If fitted)

Operation of the local communication button switches the equipment to the local simplex channel allowing direct communication with similarly switched mobiles.

The local communication lamp is lit and a piptone is heard every minute as a reminder that the local communication channel is selected and the mobile is not available on the main system. Pressing the button again reverts the mobile to the main system; the lamp will go out.

SHORT FORM CODES

Short Form Dialling

Frequently used telephone numbers or numbers with a large amount of digits may be allocated short form codes.

To initiate a call using this code press digit 2 on the keypad followed by the short form code then press the send button.

Short Form Routeing

Complex access coding systems may also be allocated short form codes.

To initiate a call using this code press digit 2 on the keypad followed by the short form code then the extension number, then press the send button.

SUMMARY OF OPERATION

Switching On:

(i) Best channel displayed

or (ii) Busy — no free channel available

or (iii) Out-of-range — too far from base station

Dialling Out:

(i) Enter digits Prefix 3 for mobile call, 4 for telephone
(Press **CL** to clear dialling error on display then start again).

(ii) Press send button (✱) and listen for ringing/engaged/NU tone.

Incoming Call:

(i) GROUP CALL — Two tone alert, no operator action

(ii) INDIVIDUAL CALL Interrupted alert, press the answer (✱) button to accept call.

Cleardown:

(i) Automatic on completion of call period

(ii) Terminate conversation by pressing terminate call (#) button.

Call Back Response:

(i) CALLED indicator lit.

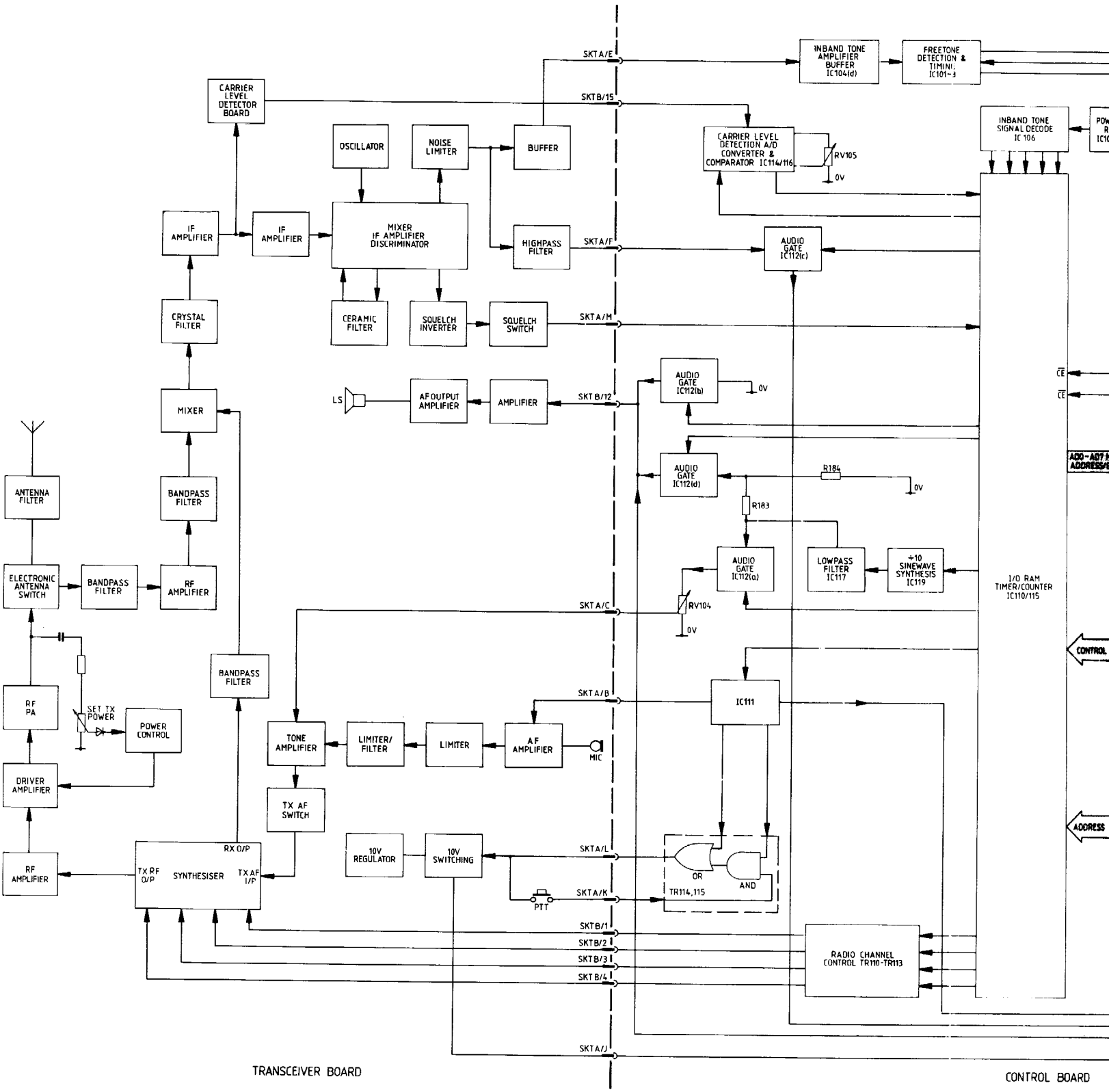
(ii) Enter '5' followed by '✱'. Listen for tone.

(iii) Store number again by entering '6' followed by '✱'.

Local Communication Channel (If fitted)

(i) Press □ button to select the local communication channel.

(ii) Press again to revert to main system.


SKT A/E
SKT B/15
INBAND TONE AMPLIFIER BUFFER IC104(d)
FREETONE DETECTION & TIMING IC101-3
CARRIER LEVEL DETECTOR BOARD
OSCILLATOR
NOISE LIMITER
BUFFER
CARRIER LEVEL DETECTION A/D CONVERTER & COMPARATOR IC114/116
RV105
0V
INBAND TONE SIGNAL DECODE IC 106
IF AMPLIFIER
IF AMPLIFIER
MIXER IF AMPLIFIER DISCRIMINATOR
HIGHPASS FILTER
SKT A/F
AUDIO GATE IC112(c)
CRYSTAL FILTER
CERAMIC FILTER
SQUELCH INVERTER
SQUELCH SWITCH
SKT A/M
LS
AF OUTPUT AMPLIFIER
AMPLIFIER
SKT B/12
AUDIO GATE IC112(b)
0V
MIXER
AUDIO GATE IC112(d)
R184
0V
R183
ANTENNA FILTER
BANDPASS FILTER
BANDPASS FILTER
AUDIO GATE IC112(a)
LOWPASS FILTER IC117
÷10 SINEWAVE SYNTHESIS IC119
I/O RAM TIMER/COUNTER IC110/115
ELECTRONIC ANTENNA SWITCH
BANDPASS FILTER
RF AMPLIFIER
SKT A/C
RV104
0V
CONTROL
BANDPASS FILTER
SKT A/B
IC111
RF PA
SET TX POWER
POWER CONTROL
TONE AMPLIFIER
LIMITER/ FILTER
LIMITER
AF AMPLIFIER
MIC
DRIVER AMPLIFIER
TX AF SWITCH
ADDRESS
RX O/P
RF AMPLIFIER
TX RF O/P
SYNTHESISER
TX AF I/P
10V REGULATOR
10V SWITCHING
SKT A/L
OR
AND
TR114,115
PTT
SKT A/K
SKT B/1
SKT B/2
SKT B/3
SKT B/4
RADIO CHANNEL CONTROL TR110-TR113
SKT A/J
TRANSCEIVER BOARD
CONTROL BOARD

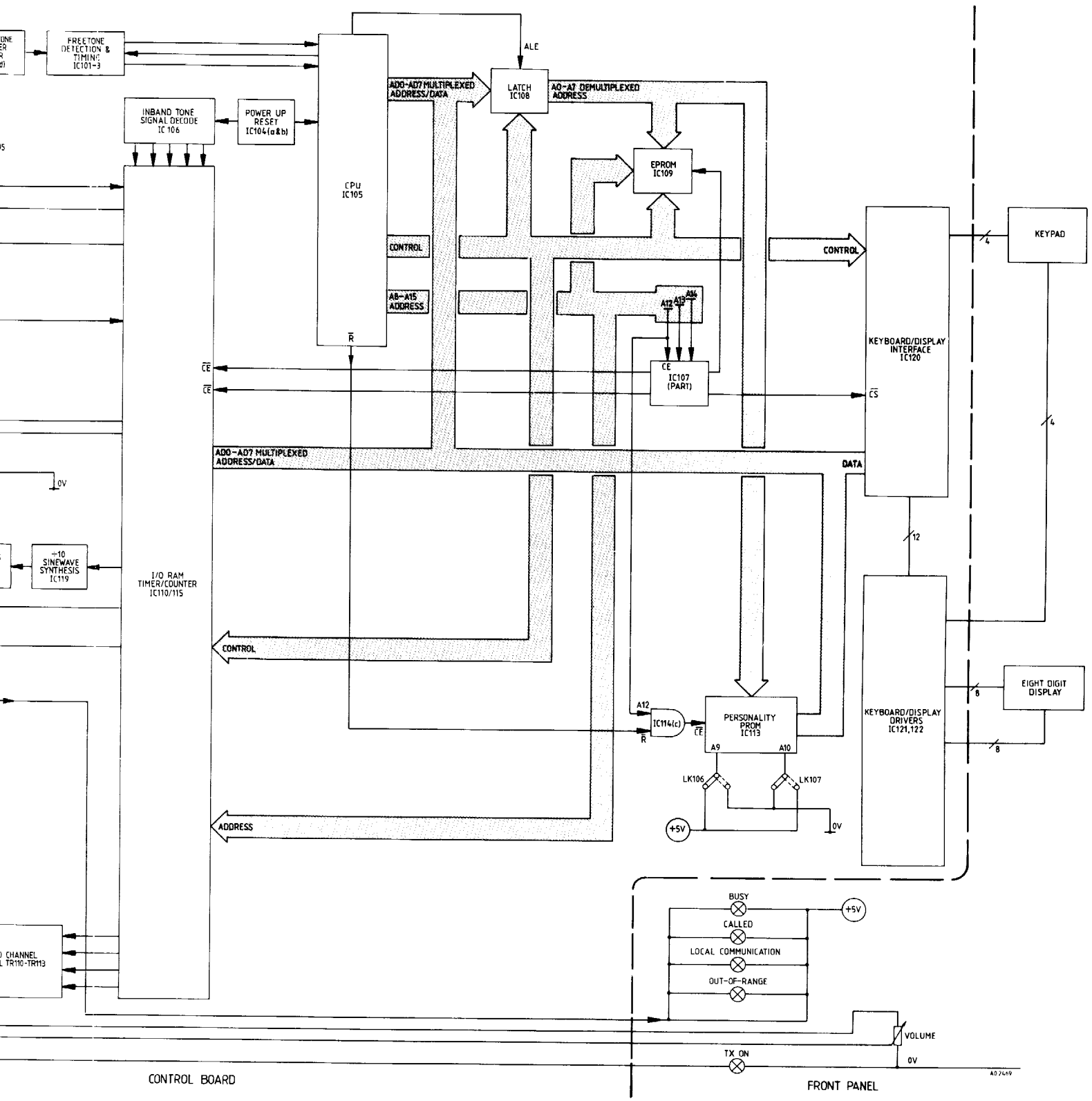


Fig. 3.2 Overall Block Diagram

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SECTION 3
TECHNICAL DESCRIPTION

INTRODUCTION

The CX290 control head comprises a control board and a front panel assembly. The control board is interfaced with the radiotelephone via SKTA and SKTB which are housed on the interconnection board. Fig. 3.1 shows the control board to radiotelephone interconnections.

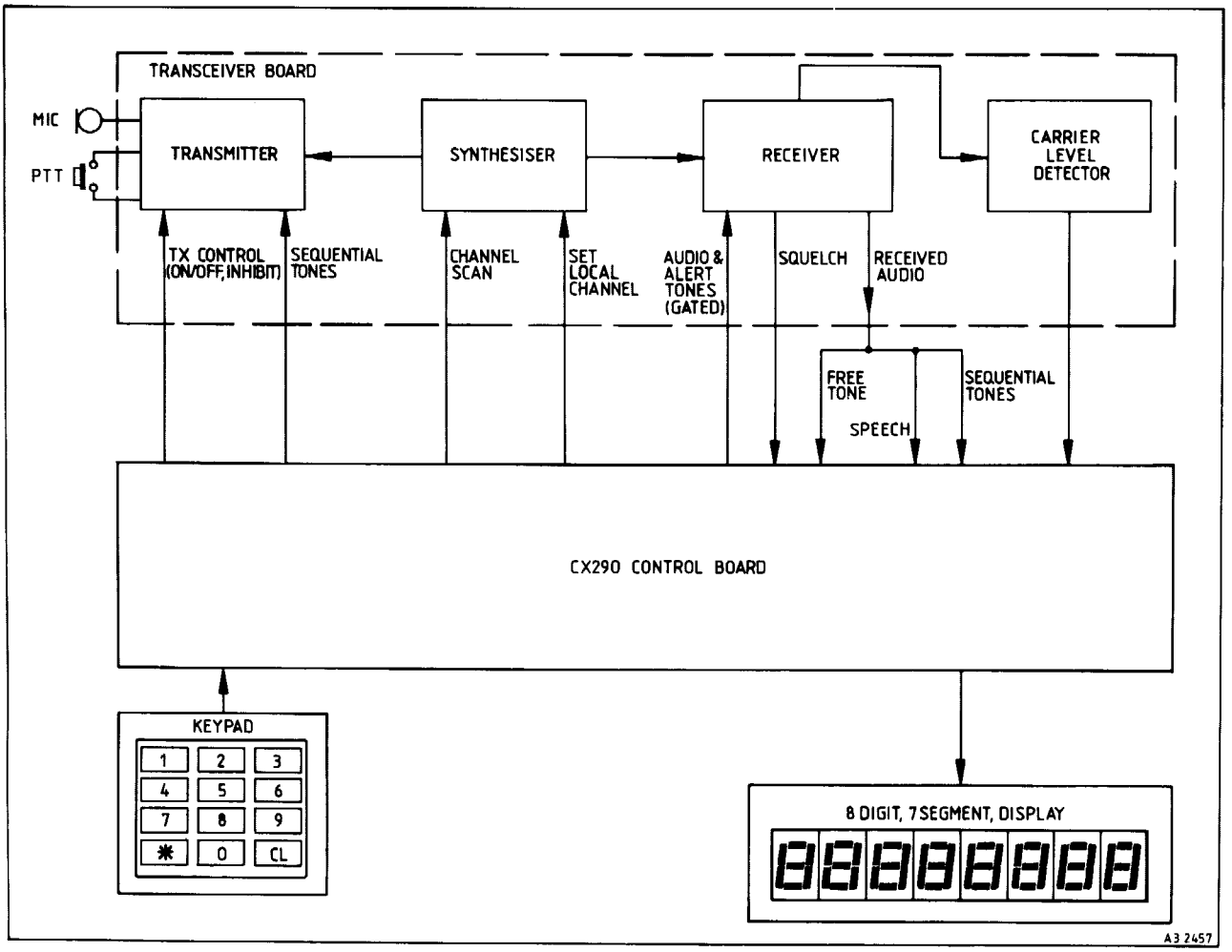


Fig. 3.1 Control & Signalling Interface

The front panel assembly houses the operators controls and incorporates a front panel control PCB which interfaces the control board, via the interconnection board.

FUNCTIONAL DESCRIPTION

The E31–300 mobile functional block diagram is shown in Fig. 3.2. The various functions of the CX290 control head are described below.

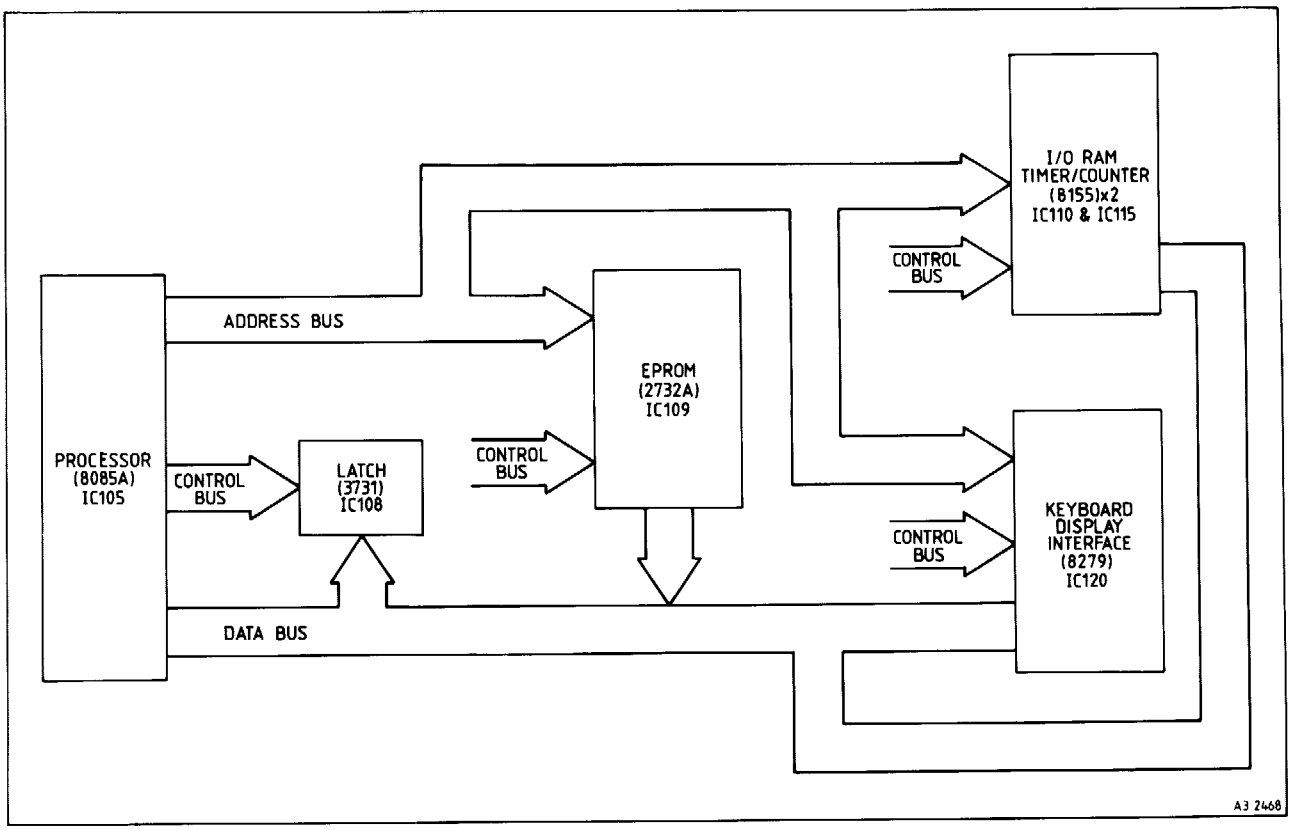
Central Processing Storage and Control

The unit is controlled by the 8 bit microprocessor IC105 which receives and distributes control signals to and from the peripheral devices. System operation is determined by the data stored in IC109.

The EPROM address is derived from the data bus via demultiplexer IC108 using the ALE control signal for latching.

RAM storage, I/O communication and basic time signal generation is provided by IC110 and IC115.

IC120 is the keyboard and display interface.



Sequential Tone Decoding

Tones from the mobile receiver are fed, via SKTA pin E, buffer TR107 and amplifier IC104(d) to the tone decoder IC106 on pin 14 which can detect any one of 15 tones in the EEA tone set. When a tone is detected within the correct bandwidth, a 4 bit code is written to the data outputs IC106 pins 9, 10, 11 and 12 and a data change indication is generated on pin 8. This is used with the hold input pin 5, in a handshake routine with the microprocessor in the decoding of the sequential data.

Single Tone Decoding (with loss time out if required)

Tones from the mobile receiver are fed via SKTA pin E and buffer TR107 to IC103 pin 10. Provided the tone is within the appropriate bandwidth of the gyrator Voltage Controlled Oscillator (VCO) centre frequency the VCO will phase lock onto the tone frequency and pin 9 of IC103 will go low. This is fed to pin 5 IC105 to enable the microprocessor to monitor the presence of the tone and, via TR104, to reset the programmable dividers IC101 and IC102 when the tone is present. When the tone disappears pin 13 of IC102 gives a pulse after a delay depending upon links LK102 and LK103. This pulse is fed to pin 9 of IC105 (RST 5.5) to inform the microprocessor that timeout has occured.

Receiver Squelch Monitoring

The state of the squelch is read from pin 37 of IC110. This is used to detect loss of carrier on which a decision to cleardown is based.

Waveform Synthesis and Filtering

Sinusoidal waveforms are generated by applying the programmable TIMER OUT divided down clock, pin 6 of IC110 to Johnson Counter IC119 weighted to provide a synthesised sine waveform. This waveform is buffered by IC117(a) and filtered by the 4-pole Chebishev Filter IC117(c) and IC117(d) before being applied to the transceiver.

Tone Generation and Audio Gating

Rx audio is gated from SKA pin F to SKA pin G by a control signal to IC112(c) pin 6. IC112 (b) presents the input of the volume control with a low resistance path to ground unless the received audio gate is open or alert tones are being generated. D114 and D115 and the base resistors of the invertor TR116 form an OR gate.

The generated inband tones are gated to SKTA pin C under the control signal to IC112(a) pin 13.

The locally generated alerting tones to SKTB pin 12 (input of the volume control) under a control signal to IC112(d).

Tx/PTT Control

TxINH: A 'high' on the base of TR115 under program control via IC111 pin 14 prevents the mobile being keyed via the PTT switch.

Tx ON: The mobile can be keyed up under program control by taking the base of TR114 'low'.

Mic Mute: During the transmission of tones, the microphone is muted by pulling IC111 pin 13 'low' (SKTA pin B).

PTT Monitoring

When the microphone PTT switch is operated + 10V is applied to SKTB pin 13, via the MX290 link field (L1 to S). The + 10V is fed, via R209, to IC115 pin 5; a schottky diode D116 clamps this voltage to + 5V.

When the PTT switch is released SKTB pin 13 is switched to 0V.

Power Up Reset

R130 and D101 provide a 2,7V reference signal which is applied to the inverting inputs of IC104 (pins 2 and 6). Potential divider R131 and R132 provides a proportion of the 10V regulated supply voltage to the non-inverting input of IC104(b) pin 5. When the output of IC104(b) switches to 10V with the rising supply voltage, C118 charges through R134 and the time taken for the voltage across C118 to reach the 2,7V reference, defines the period for which the reset line is held 'low' after the 5V supply has reached a stable condition. R135 and D103 limit the reset voltage fed to IC105 pin 36 to 4,7V.

Carrier Level Detector, A/D Converter

The analogue signal from the carrier level detector on SKTB pin 15 is divided by R191, 218, buffered by IC116(a) then gated by IC114(a) to the low pass filter R195, C141. IC116(b) is used as a comparator to compare the filtered signal with a staircase ramp voltage generated by port PB1 of IC115 writing a progressively incremented bit pattern to the R/2R ladder network RN1.

IC114(b) allows a reference signal, set by RV105, to be gated to the low pass filter in place of the signal from SKTB pin 15 for calibration purposes. IC114(d) grounds any charge stored on C141 at the start of each measurement.

Radio Channel Control

The radio channel is set via the upper nibble of PB1 from IC110 which is applied to SKTB pins 1 to 4 via the inverting buffers TR110 to 113.

Keyboard Display and Indicators

The keyboard and the eight digit 7-segment display are controlled by the processor, via IC120, a programmable keyboard and display interface chip. The keyboard and display scan lines from IC120 are decoded by IC107 and IC121; IC107 provides the active scan lines for the keyboard matrix. The return lines on pins 38, 39, 1 and 2 of IC120 are examined for key closure.

The digit driver IC121, decodes the scan lines SL0 - SL2 to provide a multiplexed signal to each of the common anode 7-segment displays, in turn.

IC122 decodes the segment drive information lines, B0 to B3 and provides to the driven segments a current determined by resistor R217 which controls the brightness of the display. $\overline{BD}$ from IC120 blanks all the displays during the time that data is being changed.

The Personality PROM

IC113 is a 4 bit x 2048 fusible link bipolar PROM which is used to store 'personality' information peculiar to the individual scheme and mobile.

The processor reads from this PROM using address lines A0 to A8, demultiplexed in the normal manner by IC108. Address lines A9 to A10 on the PROM, however, are linked 'high' or 'low' using LK106 and LK107, to allow the processor to read from one of four quadrants, each of 512 consecutive addresses, whilst presenting the same address on A0 to A8. This allows up to 4 different 'personalities' to be selected by external linking changes, typically used to select one of four different LETs.

$\overline{CE}$ for this PROM is provided by address line A12 from the processor 'ANDED' with the $\overline{RD}$ line in IC114(c) to ensure that the PROM is only enabled when it is being read - writing to this PROM is not permitted. A12 also disables the address decoder part of IC107 so no other device can be inadvertently selected at the same time as IC113.

PORT ALLOCATIONS

IC110 (8155)

Port PA1	-	All bits are output
Bit 0	-	Holds one input to the comparator sensing carrier level detector voltage, via IC114 pin 12 to zero volts in order to remove any previous residual voltage from the input.
Bit 1		Sets and resets the $\overline{HOLD}$ input of the sequential tone decoder IC106, via TR109.
Bit 2	-	Controls 'Busy' lamp via open collector darlington buffer IC111.
Bit 3		Controls local communication lamp, via IC111.
Bit 4		Controls 'Called' lamp, via IC111.
Bit 5		Effects microphone mute during sequential tone transmission, via IC111.
Bit 6	-	Provides Tx inhibit (except during speech), via IC111 and TR115.
Bit 7	-	Controls transceiver Tx 10V line, via IC111 and TR114.
Port PB1		All bits are output.
Bit 0	-	Controls 'Out-of-Range' lamp, via IC111.
Bit 1		Controls alert tone gate and shunt gate IC112(b).
Bit 2	-	Controls sequential tone gate IC112(a).
Bit 3		Controls receiver audio gate IC112(c) and shunt gate IC112(b) via TR116.
Bits 4 to 7	-	Sets mobile channel via TR110 - 113.
Port PC1		All bits are input
Bit 0		Senses squelch input from the receiver.
Bit 1	-	Senses data change output from the sequential tone decoder IC106.
Bits 2 to 5		Reads the data output from IC106.

IC115 (8155)

Port PA1 — Undedicated

Port PB1 — All bits are output

Bits 0 to 6 — Used for generation of ramp voltage for comparison with carrier level detector output.

Port PC1

Bits 0 to 3 — Undedicated (Input or Output)

Bit 4 — Senses IC116(b) output which compares carrier level detector with ramp voltage.

Bit 5 — Senses Tx 10V line from transceiver.

PERSONALITY PROM

Personality information such as mobile identity, LET etc is contained in a 2k x 4 bit fusible link PROM which is divided into quadrants each containing a different LET - all other information is common to all quadrants.

Data is stored as follows:

Address (HEX)	Data (One nibble wide)
000, 001	LET in number of 5mS periods
002, 003	Number of identity digits
004, 005	Not Used
006, 007	Not Used
008	Number of channels in scan.
009, 00A	Local Simplex channel number (if applicable).
00B	Not Used
00C	Not Used
00D	Call answer limit timer (in 5S periods)
00E	On period of call alert tone (in 100mS periods)
00F	On/Off period of call alert tone
010	Test location
011, 012	Fixed system identity
013-016	Individual identity
017	Local Communication option
018	Paging option
200 etc	2nd LET 002H -- 018H repeated
400 etc	3rd LET 002H -- 018H repeated
600 etc	4th LET 002H -- 018H repeated

DETAILED DESCRIPTION

Initialisation

At power up IC104 (a & b) and the associated circuit applies a logic 'low' to the $\overline{\text{RESET}}$ input of the 8085 processor IC105 pin 36 for a time determined by the time constant of R134 and C118 (approx 50 mS). When C118 charges above the 2,7V reference level on IC104 pin 2 the output from IC104(a) goes 'high' and the processor reads the first instruction from the program stored in the EPROM IC109. The next section of the program then establishes the required input or output mode for each port of the two 8155 interface and RAM chips IC110 and IC115, and also determines the mode of the keyboard/display chip IC120. (eg: right hand entry; auto-increment; scanned keyboard etc – see manufacturers handbook for further details).

Channel Search

Assuming that no digits have been entered from the keyboard the control board will scan the available channels looking for the strongest channel with freetone present.

The number of channels to be scanned is read from the personality PROM IC113.

The carrier level detector board fitted to the transceiver provides, for each channel, a voltage on SKTB pin 15 which is monotonically related to the signal strength received on that channel.

Reference Scan – To determine whether adequate signal strength is present on each channel scanned a reference level, switched by IC114(b), is established. This level, set by RV105 during test, corresponds to the level at IC116(a) pin 3 given by an RF input signal of 1,6μ V (approx.).

An R/2R resistor network RN1 on port PB1 of IC115 produces a voltage which increases in level as the binary count written to the port is incremented. This voltage is compared with the reference level from IC114(b) by IC116(b) and the comparator output on pin 7 is read by port PC1 of IC115. When the 'increasing' voltage from PB1 reaches a level higher than the reference voltage the comparator changes state and the count which effectively represents the reference RF signal level is stored in RAM.

Channel Scan – Each channel in turn is set by bits 4 – 7 of port PB1 on IC110, buffered by TR110 – 113 and sent to the transceiver.

The signal strength of each channel is monitored and stored as follows:

(i) Any residual voltage on the input to the comparator IC116(b) is removed by switching IC114(d) to the low resistance state for a period of 20 mS.

(ii) The voltage from the carrier level detector, representing the signal strength, is divided in the ratio R191/(R191 +R218) and is buffered by IC116(a) then switched, via analogue gate IC114(a), to the input of the comparator.

(iii) Comparison takes place between the 'rising' voltage from PB1 and the signal strength voltage. When the level from PB1/RN1 is higher than that derived from the RF signal, the comparator changes state and the count is read by the processor and compared to the reference count stored in RAM.

(iv) If the signal count is greater than the reference count the channel is checked for the presence of freetone.

(v) If freetone is present the signal count on the channel is compared with any previous count taken in the same channel scan. If the latest count is greater it replaces the record of the previous count in RAM.

When all channels have been scanned one of the following will occur:

(i) The 'strongest' channel detected, with freetone present will be set and the channel number displayed on the front panel of the unit.

(ii) If all channels, within range, are in use (ie: Carrier is detected but freetone is not present) the 'Busy' (green) lamp is lit.

(iii) If no carrier is detected on any channel the 'Out-of-Range' (yellow) lamp is lit.

If conditions (ii) or (iii) exist scanning continues until a channel with freetone is found.

Freetone Detection

When during the scan, a channel of sufficient strength is found further time is allowed for the presence of freetone to be checked.

The freetone burst, demodulated by the receiver, on SKTA pin E is buffered by TR107 and a proportion of the signal, set by RV103 is passed to the gyrator IC103. RV102 sets the centre frequency of the narrow bandwidth filter. If the freetone frequency falls within the filter bandwidth the gyrator output is 'low' (less than 0,4V). ; if the frequency is outside the bandwidth the output remains 'high' (greater than 4V). The output is checked by the processor IC105, via the SID (Serial Input Data) pin 5 and is also used to reset Johnson counters IC101, IC102 via TR104.

Once the 'strongest' channel (with freetone) is set a constant check is made on the presence of freetone. When the freetone burst (which occurs every 2,1 S approx.) disappears the control board response depends on which of the following conditions exist at the time:

(i) Mobile Out-of-Range

(ii) Channels Busy

(iii) Send Call Initiated

(iv) Receiving a call

(i) Mobile Out-of-Range

Scanning re-commences and continues until a channel with freetone is found.

(ii) Channels Busy

Scanning recommences and continues until a channel with freetone is found.

(iii) Send Call Initiated

The mobile pauses to allow any 'overhang' of carrier from the freetone transmission to disappear then the carrier level detector output is read to determine whether the channel is now being used by the base.

The inter-freetone period is divided into two 1 second timeslots used for transmission of messages.

If the first timeslot is free (ie: no carrier) a random decision is taken on which timeslot to use; if a carrier is detected at the start of the first timeslot the second timeslot is looked at and if no carrier is present the message is sent. If a carrier is detected in both timeslots the call is aborted.

When a timeslot is available the mobile transmits an 'Initiate call' message using sequential tones.

(iv) Receiving a Call

At the end of the freetone burst the mobile continues to monitor the channel for the re-appearance of freetone.

Whilst freetone is not present any incoming sequential tones are decoded. If the identity is correct the mobile expects the message to be a Group Call or Interrogate.

Sequential Tones Transmission

The transmitter is switched on, via Darlington buffer IC111 enabling TR114 which connects the 10V line to SKTA pin L. The front panel Tx indicator is driven by the Tx 10V line from the transceiver.

When the LET expires the timer of IC110 is started which drives the Johnson counter IC119, via TR118, to give digitally synthesised sinewave of the frequency of the first sequential tone of the message.

The output from IC119 is fed, via IC117(a) to a four pole active filter based on IC117(d) and IC117(c). The resultant sinusoidal waveform is switched by analogue gate IC112(a) and passed to SKTA on pin C (the in-band tone input to the transceiver) at a level set by RV104.

The length of each sequential tone is set by the processor using the 5 mS square wave output from IC115 pin 6. The frequency generated by the timer of IC110 is changed at the end of each tone period to that required for the next tone. At the end of the last tone, the sequential tone gate IC112(a) is closed, and the timer of IC110 stopped.

Acknowledgement of an 'Initiate Call' message is sent from the base station but must be received within 200 mS + LET to be valid. This time is measured by counting the 5 mS pulses from IC115 on the 7.5 interrupt of the processor IC105.

Sequential Tones Decode

An 'Initiate Call Acknowledge' from the base station is demodulated in the transceiver and fed via SKTA pin E to the buffer TR107 then amplified by IC104(d). IC106 gives a binary equivalent of the digit which corresponds to each tone on its Q0 – Q3 outputs; a new tone frequency causes the data change output on IC106 pin 8 to change state. This change is read via bit 0 on port PC1 of IC110 and enables the processor to latch the output information by taking the $\overline{\text{HOLD}}$ input of IC106 'low', via TR109. The data on bits Q0 – Q3 is then read via PC1 of IC110 and compared by the processor with the expected digit.

The first two digits of a message indicate system identity and the next four the mobiles individual identity. Each of these six digits will be compared with those read from the personality PROM IC113 and if they all correspond the next three digits are read. These three digits indicate the channel number (which must correspond to the channel selected on the mobile) a system number (which is always 1), and the seventh digit indicates the type of message received.

Full details of the message format are given in this section.

The timer of IC115 is used to check the duration of each tone received.

On receipt of an 'Initiate Call Acknowledgement' the mobile transmits the dialled digits entered from the keypad; the display goes blank.

If freetone is not detected within 4 seconds of pressing the send button a local 'Number Unobtainable' tone is generated.

Alert Tone Generation

The timer of IC110 is started and produces a frequency which is divided by 10 in the Johnson Counter IC119 to give a digitally synthesised sinewave filtered by IC117(d) and IC117(c). This frequency is passed to the analogue gate IC112(d) via potential divider R183, R184. The output of IC112(d), is fed directly to the slider of the volume control; IC112(b) is also connected to the same point (via C128) and acts as the shunt arm of a potential divider. The two gates may be switched on and off by the processor, via bit 3 of PB1 on IC110. Inverter TR116 switches the shunt arm to its low resistance state when the series arm is high resistance, and vice-versa. In this manner an interrupted cadence is generated (Eg: NU, Call Alert etc.).

Group Call

The timer of IC110 is started producing a frequency which gives the first tone of the two tone 'Group Alert' at the input to the analogue gate IC112(d). This gate is enabled and the shunt gate IC112(b) disabled allowing one second (approx.) of tone to be heard. After this time the two gates change state and the 'received audio' gate IC112(c) is enabled feeding audio from SKTA pin F to the top of the volume control. The shunt gate IC112(b) is switched to the high resistance state by 'OR' gate D114, D115, and inverter TR116. The second tone of the two tone 'Group Alert' is received from the base station; conversation may now take place.

Interrogate

The mobile responds to an 'Interrogate' message by returning an 'Interrogate Acknowledge' sequence. The base station then sends 'Initiate Call' which causes the mobile to generate a 'Call Alert' tone in the same manner as a 'Group Alert' tone.

Call Answer Limit

The 'Call Answer Limit' time is read from the personality PROM IC113. The 5 mS pulses from IC115 are used to count the elapsed time whilst the alert tone cadence is produced.

The keyboard is constantly monitored during this time in order to detect when the answer button is pressed (call accepted).

Keyboard Scanning

De-multiplexer IC107 (part) enables the keyboard/display chip IC120 to scan the keyboard switches. The state of each row of switches is received by IC120 on return lines RL0 – RL3.

IC120 generates a 1 to 8 count on scan lines SL0, SL1 and SL2 using SL2 as chip enable so that only the 4 lines used are scanned. Each line connects to a row of switches 2Y0 – 2Y3.

As each row is scanned the return lines are read. If a switch is pressed a 'high' appears on the appropriate return line.

Detection of a 'high' returned from a particular row identifies the switch that is pressed. When a key depression is detected the 6.5 interrupt on pin 8 of the processor is driven 'high' by IC120 indicating that data from the keyboard on the output of IC120 is waiting to be read. Further data may be entered (IC120 pin 4 goes 'low' briefly then 'high' again) until the contents of the internal 'First in; First out' (FIFO) register are read.

If the answer button is pressed during the call answer limit time the audio path and transmitter PTT are enabled. Conversation may taken place.

Display Control

The eight 7-segment displays are controlled by the processor, via IC120.

The digit driver IC121 decodes the scan lines SL0 – SL2 providing a multiplexed signal to the common anode 7-segment displays. A $\overline{BD}$ signal blanks the display during digit switching or by a display blank command.

IC122 is a decoder/driver which accepts the 4-bit word command on B0 – B3 and provides to the appropriate segments a – g drive current set by R217 to control display brightness.

Transmitter Control

Control of the transmitter is achieved using TR114 and TR115 as follows:

(i) Transmitter automatically keyed.

Bit 7 of port PA1 on IC110 goes 'low' causing IC111 pin 15 to go 'low' switching on TR114. The 10V line connects to SKTA pin L to key the transmitter.

(ii) Microphone PTT switch keys transmitter

Bit 6 of port PA1 on IC110 goes 'low' causing IC111 pin 14 to go 'low' switching on TR115. The 10V from the microphone PTT switch on SKTA pin K supplies current to SKTA pin L switching on the transmitter.

(iii) Microphone PTT switch disabled; transmitter off.

Bit 6 of PA1 on IC110 is set 'high'; IC111 holds TR115 base 'high'. Therefore, irrespective of the level on the PTT input, SKTA pin K, no current is supplied, via SKTA pin L. Transmitter remains off.

Freetone Timeout

Whilst freetone is received the output of the gyrator IC103 is 'low' and a reset is applied, via inverter TR104, to the Johnson Counter IC101, 102.

When freetone disappears the reset is removed and IC101, 102 start to count down; the length of the count is set by LK102, 103. Provided another burst of freetone appears before timeout occurs IC101, 102 reset and the processor continues to monitor the selected channel.

If freetone fails to reappear timeout occurs and the output from IC102 sends the 5.5 interrupt of the processor (IC105 pin 9) 'high' causing the processor to search for a free channel.

Squelch Monitor

During conversation, signal level is monitored, via the squelch input on SKTA pin M, and is read by the processor using bit 0 of PC1 on IC110.

If carrier is not present for longer than a specified time the mobile clears down locally.

Address Decode

The data bus of the 8085 processor is multiplexed with the lower eight bits of the address bus. The address latch IC108 latches the address information onto its output using the ALE (Address Latch Enable) output of the processor to indicate when the information is valid.

Bits 13 and 14 of the address bus are used by IC107 (part) to give a '1 of 4' chip select output, which allows the EPROM IC109, RAM I/O chip IC110 or IC115 or the keyboard/display chip IC120 to be selected.

Selection of the personality PROM IC113 which must only be enabled during the time data is being read is achieved by 'ANDing' the $\overline{RD}$ output and the A12 address line from the processor in analogue gate IC114(c). The output is fed as $\overline{CE}$ to IC113.

At the same time the A12 output takes IC107 pin 11 'high' ensuring that IC109, IC110, IC115 and IC120 are disabled.

LOCALLY -- GENERATED TONES AND CADENCES

Number Unobtainable Tone (NU)

Frequency : 425 Hz ±15 Hz
Cadence : 62,5 mS ±6,2 mS tone, 62,5 mS ±6,25 mS pause.

This tone sounds for 2 seconds (approx.) after the mobile user has attempted to make a call and:

(i) Freetone is not detected within 4 seconds of the Send button being pressed.

(ii) An 'Initiate Call' response is not received from control within one second of the mobile transmitting its 'Initiate Call' message.

Call Alert Tone

Frequency : 1700 Hz +60 Hz
Cadence : 1000 mS ±250 mS tone
4000 mS ±500 mS pause

This tone sounds during the 'Answer Limit' period, until the mobile user presses the answer button or a 'Cleardown' message is sent from control.

Pip Tone

Frequency : 425 Hz ±15 Hz
Cadence : 250 mS ±25 mS tone, 60 S ±6 S pause

This tone sounds when the mobile user has selected the local communication channel.

TIMERS

Handshake Timer: 1 second

Answer Timer: User specified.

This timer is started when mobile receives a 'Call' message from control. If the mobile user does not answer the call within this time, the mobile will remove the alert tone from the loudspeaker, disable its keypad and monitor the channel for the 'Page Dial Limit' time.

Pager Limit Timer: 40 seconds

This timer starts when the 'Answer Limit' timer expires.

This allows the telephone user to key his own extension number into the control unit store without the mobile interrupting.

MESSAGE FORMAT

Signalling between the base station and the mobile takes the form of a 9 digit message; each digit 40 mS long.

The function allocated to each digit is as follows:-

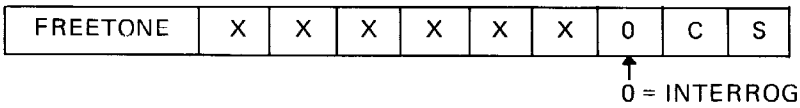
1st and 2nd digits	User identity 0 – 9. These two digits will be added automatically by the base station control unit when signalling to a mobile.
3rd – 6th digits	Mobile identity 0 – 9.
7th digit	Type of message. (Eg: Interrogate, Call, Clear etc)
8th digit	Channel number 1 - 8
9th digit	Base station control unit number. Always 1

Digit 'Value'	Tone Freq (Hz)
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
0	1981
A	1055
B	930
E (Repeat)	2110

The 'value' of each digit is determined by the type of message sent. A different tone frequency represents each value.

Messages from Control to Mobile

Interrogate

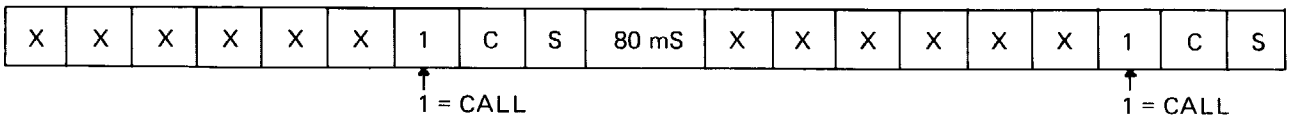


C = Channel number on which the message is transmitted. Mobile will acknowledge on the same channel.

S = Control unit number.

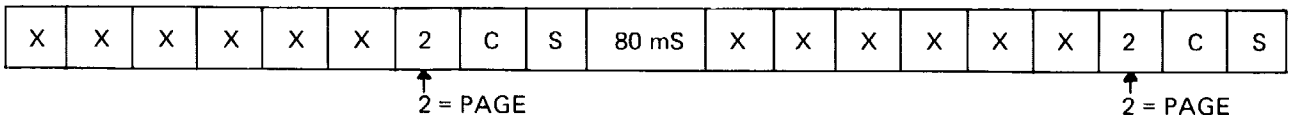
The interrogate message is transmitted on all relevant channel preceding a 'Call Message'. On receipt of this message the mobile will acknowledge with the same message on the same channel and will hold the channel for 1 second for a call message.

Call Message



This message is transmitted on the channel the Interrogate Message from mobile is received on. On receipt of this call message the mobile will sound an alert tone in the mobile loudspeaker for the 'Answer Limit' time or until the mobile user responds to the call.

Page Message

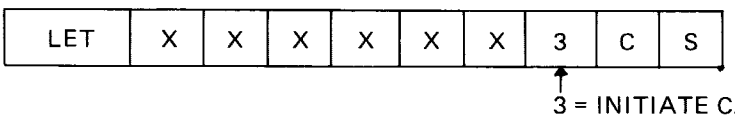


This message is transmitted to the mobile when the 'Call' message is not received from the mobile and the telephone subscriber has subsequently dialled the required extension number into the control unit store.

On receipt of the message the mobile 'Called' lamp will light and the single frequency simplex channel is selected and the pager is called. The mobile then reverts to searching for freetone.

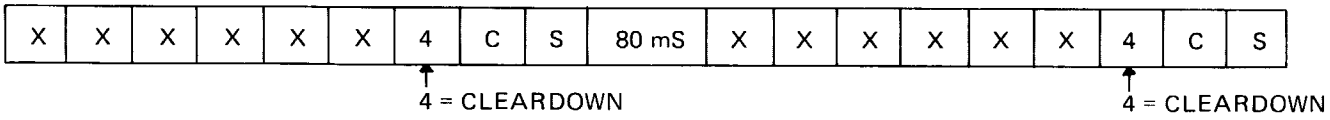
Freetone will be re-instated on the channel which the mobile was called on making it available for other traffic.

Initiate Call



This message acknowledges the Initiate Call message from the mobile. The 'Dial Digits' message should be received from the mobile not more than 1 second after the transmission of this message.

Cleardown



On receipt of the cleardown message the mobile is reset and starts to search for freetone to lock-on to. The mobile must be able to act upon this message at any time.

C = Channel number,

S = Control Unit number.

All Call

←500 mS→

FREETONE	X	X	A	E	A	E	Y	C	S	80 mS	X	X	A	E	A	E	Y	C	S	ALERT

If Y = 6 all mobiles open the loudspeaker and enable the PTT switch.

If Y = 4 all mobiles are reset.

The mobile will not acknowledge any of these messages and the send and terminate call buttons will not initiate a message. Pressing the terminate call button will reset the mobile. The alert tone is the same frequency as the freetone.

Group Call

Group 12

←500 mS→

FREETONE	X	X	1	2	A	E	Y	C	S	80 mS	X	X	1	2	A	E	Y	C	S	ALERT

If Y = 6 all mobiles in Group 12 open the loudspeaker and enable the PTT switch.

If Y = 4 all mobiles in Group 12 are reset.

The mobile will not acknowledge any of these messages and the send and terminate call buttons will not initiate a message. Pressing the terminate call button will reset the mobile. The alert tone will be the same frequency as the free tone.

Messages from Mobile to Control

Interrogate

LET	X	X	X	X	X	X	0	C	S

X = Identity
C = Channel Number
S = Control Unit Number

This message is transmitted as an acknowledgement to an Interrogate message from control. The mobile will stay on this channel for up to 1 second for a 'Call Message' from control. If a 'Call Message' is not received by the mobile it will search for freetone.

Call

LET	X	X	X	X	X	X	1	C	S	80 mS	X	X	X	X	X	X	1	C	S

1 = CALL 1 = CALL

This message is transmitted on the channel on which the 'Call Message' is received from control. It is sent when the mobile operator answers the call by pressing the answer button. C and S will be set to the same value as the 'Call' message transmitted from control.

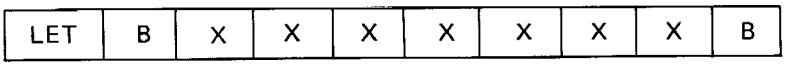
Initiate Call

LET	X	X	X	X	X	X	3	C	S

3 = Initiate Call

This message is transmitted after the mobile operator has keyed in 'Dialled Digits' into the mobile store and has pressed the send button. C is set to the channel number onto which the mobile is locked. When the 'Initiate Call' message is received from control, the mobile will transmit the 'Dialled Digits' message.

Dialled Digits

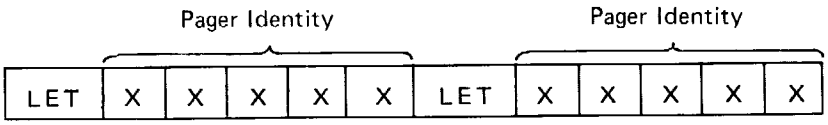


B defines the start and end of Dialled Digits.

This message is transmitted when a valid 'Initiate Call' acknowledge message is received from control.

Maximum number of digits is 16.

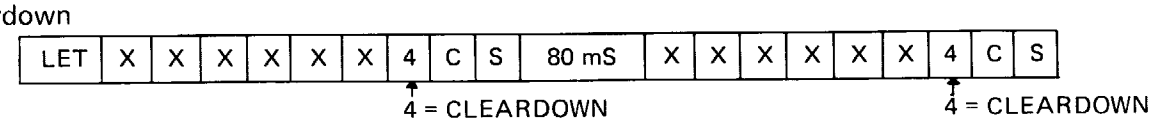
Selcall



Pager Identity uses digits 2 to 6 of message format between mobile and control.

This call is transmitted on the single frequency simplex channel after receiving a 'Page' message from control. The 'Page' message also lights the 'Called' lamp. Once the pager has been called the mobile will start again to search for freetone on the main system.

Cleardown



This message is transmitted when the mobile subscriber presses the terminate call button. This is transmitted on the channel that the mobile is using. Therefore, C will be set to the same number as used in the call set up messages.

SECTION 4
SERVICING

PRECAUTIONARY NOTES AND GENERAL INFORMATION

> **CAUTION**
>
> **Integrated circuits IC109 and IC113 may be obtained from a number of different sources. Although devices from different manufacturers are directly interchangeable once programmed, programming procedures vary. It is imperative, therefore, that this device is programmed strictly in accordance with the manufacturers instructions.**

Metal Oxide Silicon Devices

The field effect transistor and C-MOS integrated circuits used in this equipment are metal oxide silicon devices. Because they have an extremely high input impedance, they are susceptible to damage when subjected to high transient voltages or static electrical charges. To eliminate the possibility of damage the following precautions must be taken:

a) Device leads must always be in contact with a conductive material to avoid the buid-up of static charges.

b) Soldering iron tips, tools and metal parts of test equipment used during servicing must be grounded.

c) To avoid transient voltage spikes, devices must not be inserted into, nor removed from, circuits with power applied.

d) Signals must not be applied to integrated circuits in the absence of power supplies to the devices.

Pozidriv Screws

Special screwdrivers are required for use with Pozidriv headed fixing screws. Pozidriv screwdriver No. 1 is suitable for screws up to metric size M3, screws larger than this require the use of a Pozidriv No. 2 screwdriver. The use of any other type of screwdriver can result in severe damage to the screwhead.

Component Mounted on Heatsinks

A heatsink compound such as DOW-Corning Type 340 or RS Component Ltd Catalogue No. 554/331 must be applied between the component, insulating washers and the heatsink surface to provide a good thermal path.

Soldering

Soldering operations should be kept to a minimum. Ensure that the equipment is switched off before commencing any soldering operation.

The amount of solder used and the dwell time of the soldering iron should be kept to the minimum required for practical purposes. Avoid excessive heat by using heat shunts, and always check that the holes in the PCB are clear of solder before fitting a component.

Wherever possible a low voltage DC soldering iron with an earthed bit, should be used, and when soldering wire ends into plated-through holes in a PCB, care should be taken that the solder flows through the hole to emerge on the other side of the board.

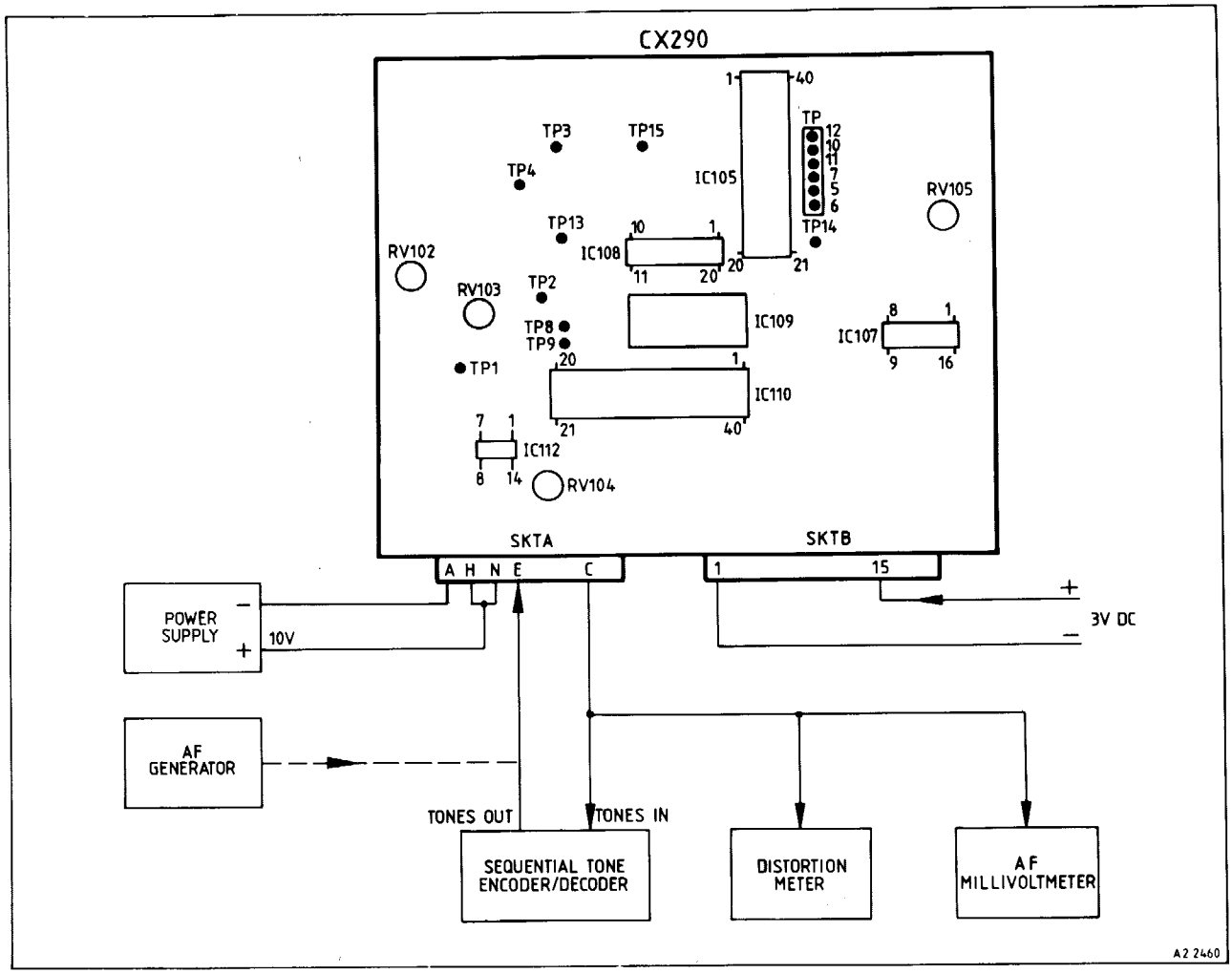


Fig. 4.1 CX290 Control Board Test Circuit

Printed Circuit Boards (PCB)

Particular care should be taken not to bend a PCB when removing, replacing, or working on it, as this may cause hairline breaks in the printed tracks, and such breaks are difficult to locate. DO NOT connect test leads to a printed track. Test links are provided at certain points, to facilitate testing and servicing, and should be used whenever possible.

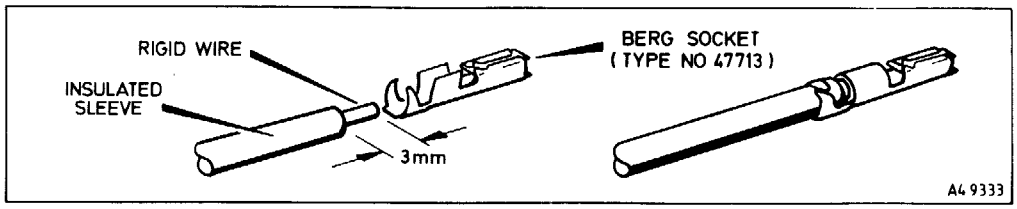
Fault finding – Integrated circuits (IC's)

In the event of the apparent failure of an IC all external components should be checked to prove the serviceability, or otherwise, of the IC before replacing it.

It is essential that these checks should be carried out, otherwise the original cause of the failure could still be present and damage the replacement item.

Test Points (TP's)

Test points take the form of Berg pins, whose locations are silk screened on the component side of the board. It is recommended that a suitable connector and lead is locally made to fit the pins, as shown in the diagram below:–



Replacement of wire-ended Components

When replacing wire-ended components, ensure that the wires do not protrude more than 1 mm beyond the track suface. Failure to do this may result in short-circuiting the component to the casing.

Connector Pin Cleaning

Under no circumstances should connector pins be cleaned using any abrasive or corrosive agent. Grease or dust contamination should be removed by use of a cleaning fluid such as Rs Components Ltd Catalogue No. 554/75.

CONSTRUCTION

The radiotelephone circuits are accommodated on a single PCB secured by means of lugs and screws to a zinc alloy diecast frame which forms a rigid box structure with substantial screening properties.

The control circuits are accommodated on a separate PCB which is secured to the front panel, and connected to the front panel control PCB, via the interconnection board. Both the front panel and interconnection PCB's are housed within the front panel assembly.

Separate diecast top and bottom covers are used to allow access to the equipment for alignment and servicing without compromising screening and rigidity.

A diecast aluminium finned casting serves both as equipment rear panel and as a heatsink for the transmitter power transistors. External connections for DC power, antenna, microphone and loudspeaker are made via flying leads from the rear panel. All electrical connections are filtered as they pass through the rear panel to ensure compliance with the latest CEPT case radiation specification.

With the exception of the microphone press-to-talk switch, all operator controls are located on the front panel assembly and comprise a 12 button keypad, volume control, on/off button and local communication and terminate call buttons. An eight digit display indicates selected channel and verification of keypad entry. Indicators are provided for power on/off, local communication channel selected, called, busy, transmit and out-of-range.

TEST PROM

To undertake any serious fault finding on the CX290 control board requires the use of a special test EPROM AT60044 which facilitates testing by allowing the tester direct access to various functions, such as setting a channel and opening the audio and tone gates. The software will also permit the display of incoming signalling, the monitoring of various internal functions and the display of error messages. Also available is a signature analysis program which can be accessed from the keyboard and which will check READ and WRITE functions to and from the RAM chips.

POTENTIOMETER FUNCTIONS

See Fig. 4.1 for location of RV101 – 105.

RV101 - Gyrator output

Adjusts the gyrator output level when LK104 is set A to C (decode mode).

RV102 – Gyrator frequency

Sets the frequency of the tone detected/encoded by the gyrator.

RV103 – Gyrator input

Adjusts the gyrator input level when LK104 is set A to B (decode mode).

RV104 -- Sequential tone output

Sets the level of the sequential tones to the transceiver board.

RV105 – Level detector reference

Sets the reference voltage of the carrier level detector circuit.

TEST EQUIPMENT

The following is a list of suitable test equipment for the alignment fault location and repair of this equipment. Equivalent types may be used provided that due corrections are made for any differences in characteristics particularly input and output impedances.

Description	Type(s)
Power Supply, 10 – 15V DC	Kingshill 18V C10
RF Power Meter, 50Ω, 50W, 68–470 MHz	Termaline 6154
Multimeter, 20kΩ/V	AVO 8
RF Signal Generator	Racal 9082
Modulation Meter	Racal 9008
AF Millivoltmeter/SINAD meter	Lyons Instruments S - 103
Distortion Meter	Lyons Instruments D10
Frequency Counter	Racal 9916
AF Generator	Levell TG200DMP
Sequential Tone Encoder/Decoder	Schlumberger 4920 or Systron Donner FOGA 5
Signature Analyser	Hewlett-Packard HP5004A
Storage Oscilloscope	Gould OS4020 (Digital) or Philips PM3219
T-Attenuator, 40 db	Marconi 54452-011
Test EPROM	Part No: AT60044
Test Personality PROM	Part No: AT60045
Signature Analysis Test Module	Part No: SH10044
20 Way Extender (with Test Points)	Part No: SH10045
Standard 16 way Extender	Part No: SH10018
Capacitor C1	See Fig. 4.4
Microphone and Loudspeaker	As supplied with mobile

***Note:** If an AVO 8 or similar multimeter is used, it is recommended that a probe set such as the following is used:*

Radiospares type 1	423 – 431 (Red and Black)
Radiospares	423 – 633 (Red)
	423 – 649 (Black)

TEST PROCEDURE – CX290 CONTROL BOARD

1. Test Equipment Connections

Connect CX290 control board to test equipment as shown in Fig. 4.1. Set power supply output to 0V and current limit to 800 mA.

2. Voltage Regulator

Connect multimeter as follows:

–Ve lead to TP9
+ Ve lead to TP15

Switch on power supply set to 10V and check that the current drawn is less than 0,5A.

Check voltage at TP15 is 5V ±0,25V

If voltage at TP15 is incorrect check the 5V regulator – IC118, R207, 208, C138 – 140.

3. Reset Circuit

(a) Using the oscilloscope monitor the DC voltage at TP4 and check that the level is 5V ±0,25V.
Slowly decrease the power supply output until the voltage on TP4 suddenly drops below 0,6V; check that when this occurs the voltage on TP2 is 6V ±0,5V.

(b) Set the power supply output to 12V and switch off the PSU. Switch on the power supply and check that the voltage on TP4 is initially less than 0,6V (for 40 – 60 mS) then rises to greater than 9,4V.

If test 3(a) and 3(b) cannot be carried out satisfactorily check the power-up reset circuit – IC104 (a & b), R130 – 138, C118, D101 – 103, TR108.

4. LED Segments

(a) Remove the operational EPROM IC109 and insert the test EPROM.

(b) Check that on power-up the display shows all eights. Press the terminate call button and check that a dash runs continuously through the display (key entry prompt).

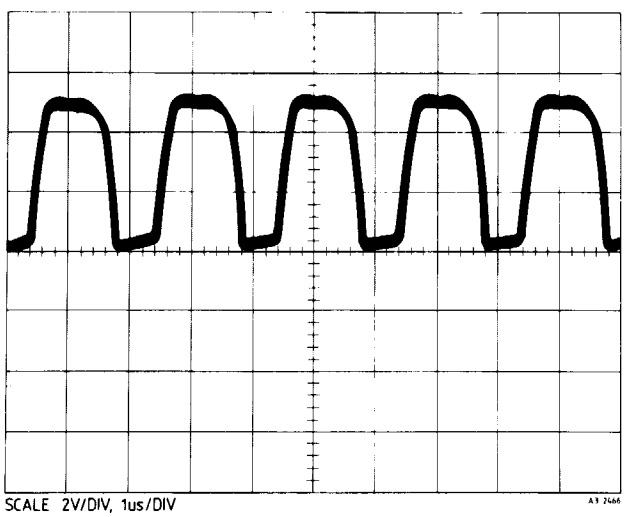
(c) Enter digits '00' and check that all eights are displayed again. Go to step 6.

If all eights are not displayed at power-up check the following:

- ***(i) Signature analysis as given in step 5.***
- ***(ii) Display drivers IC120, 121, 122, 107.***
- ***(iii) Connections between control board and front panel.***
- ***(iv) Value of R217 (should be 820R).***
- ***(v) Presence of clock frequency on IC120 pin 3.***

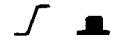
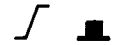
5. Hardware Signature Analysis

(a) Connect the oscilloscope to TP12 (IC105 CLK) and check that the following waveform is present.



If this waveform is not correct check the oscillator circuit -- TR101, C101 – 108, IC105 pin 1.

(b) Connect the signature analyser as follows:

Sig. Analyser Pod Connections	Switch Polarity	Connection
START		TP5 (A15)
STOP		TP6 (A15)
CLOCK		TP7 (ALE)
GND	—	TP14 (GND)

Remove the test EPROM and insert the signature analysis test module into the EPROM socket.

With the signature analyser correctly connected the signature on TP15 (+5V) should be 0001.

If the signature on TP15 is correct check the following signatures:

Connection	Signature	Connection	Signature
IC108 pin 2 (A0)	UUUU	IC105 pin 23	HPPO
IC108 pin 5 (A1)	5555	IC105 pin 24	1293
IC108 pin 6 (A2)	CCCC	IC105 pin 25	HAP7
IC108 pin 9 (A3)	7F7F	IC105 pin 26	3C96
IC108 pin 12 (A4)	5H21	IC105 pin 27	3827
IC108 pin 15 (A5)	OAFA	IC105 pin 28	755P
IC108 pin 16 (A6)	UPFH	IC107 pin 4	822A
IC108 pin 19 (A7)	52F8	IC107 pin 5	C5U3
IC105 pin 21 (A8)	HC89	IC107 pin 6	ICFH
IC105 pin 22 (A9)	2H70	IC107 pin 7	U6U2

Disconnect the signature analyser and remove the signature analysis module. Refit the test EPROM and complete step 4.

6. Keyboard and Display

(a) Press the # button and check that a dash runs continuously through the display (key entry prompt).

(b) Enter digits '01' and check the display shows '01'.

(c) Enter digits '1 to 8' in turn and check that the display corresponds.

(d) Press the CL button and check that the display clears.

(e) Enter digits '9' and '0' and check that the display corresponds.

If these tests cannot be performed check the following:

(i) Connections between the control board and front panel.
(ii) Display drivers IC120, 121, 122, 107.

Then carry out the signature analysis detailed in step 7.

7. Software Signature Analysis

(a) Press the # button and check that a dash runs continuously through the display (key entry prompt).

(b) Enter digits '00' and connect the signature analyser as follows:

Sig. Analyser Pod Connections	Switch Polarity	Connection
START	⎍▬	TP8 (PA0 – IC110)
STOP	⎍▬	TP9 (PA0 – IC110)
CLOCK	⎎▬	TP11 ($\overline{WR}$)
GND	—	TP14 (GND)

Check that the signature of the 5V supply line (IC110 pin 40) is 254C.

Check that the following signatures are correct:

Data Line	IC110 Connection	Signature
Ad 0	Pin 12	U84H
Ad 1	Pin 13	UP11
Ad 2	Pin 14	UU84
Ad 3	Pin 15	UUP5
Ad 4	Pin 16	CUU8
Ad 5	Pin 17	PUUP
Ad 6	Pin 18	3CUH
Ad 7	Pin 19	8PUH

If the signatures are correct disconnect the signature analyser and repeat step 6.

If any signatures are incorrect check the following:

(i) Two adjacent signatures identical could be due to a short circuit.

(ii) Incorrect data line signature may be caused by an open circuit.

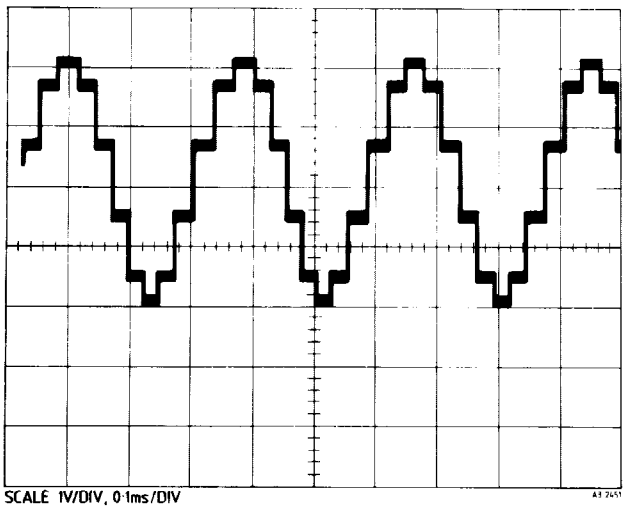
(iii) Unstable signatures could be caused by a faulty RAM chip IC110, 115.

(iv) Incorrect signatures(s) not due to short circuit or open circuit conditions – check IC105, 108, 109, 110, 113, 115, 120.

(v) Signature analyser fails to gate – suspect IC110.

8. Distortion and Frequency Response

(a) Connect the oscilloscope to TP13 set to 1V/cm, 0,1 mS/cm.
Press the ◻ button and visually inspect the waveform for symmetry.



If waveform is incorrect check IC119, D104 – 113, R200 – 205, R212 – 214, TR118.

(b) Connect the output of the tone encoder/decoder to SKA pin E. Set tone and adjust level to 100 mV ±10 mV RMS on AF millivoltmeter. Connect the oscilloscope, distortion

meter, AF millivoltmeter and the input to the sequential tone encoder/decoder (EEA/CCIR, 1% bandwidth, 40 mS timing) to SKA pin C.

(c) Press the CL button and enter digits '1;1'; check that the display corresponds.

(d) Press the □ button and check that '1' is displayed on the sequential tone encoder/decoder. Adjust RV104 until the AF millivoltmeter reads 600 mV ±50 mV. Press the □ button again and check that the millivoltmeter reading does not vary by more than 2 db. Check that the distortion is less than 2%. Operation of the □ button generates the first tone of the sequence, successive pushes step through the sequence.

(e) Press the CL button, enter digits 11111, then press the ✱ button and check that the sequential tone encoder/decoder decodes the sequence. If the distortion is greater than 5% check the filter components around IC117 (c & d).

If no tone output check the above components plus the audio gates IC112(a – d) and associated components.

9. Tone Decode

Press the # button and check that a dash runs continuously through the display.

Enter digits '02' and send digits '11111' from the sequential tone encoder/decoder. Check that unit decodes correctly.

If the unit does not decode check the decoder circuit – C115 – 117, 119 – 122, R139 – 147, 153, 163, 167; RV103, TR107, 109; IC106.

10. Freetone Timer

(a) Connect the AF generator to SKA pin E set to 500 Hz ±5 Hz at 100 mV ±5 mV.

(b) Adjust RV103 to give a level of 50 mV RMS (140 mV ptp) ±5 mV at TP1.

(c) Set RV102 to give a dip on the meter at TP3; check that the level is less than 0,3 V DC.

Vary the frequency of the AF generator and check that the level is less than 0,3V DC for 500 Hz ±7,5 Hz and greater than 3,4V DC outside the range of freetone ±17,5 Hz.

(d) Switch off the AF generator.

(e) Press the # button and check that a dash runs continuously through the display.

Enter the digits '03' switch on the AF generator and check the display shows all dashes; switch off generator. After 2 seconds (approx.) check the unit shows a four digit number in the range 2000 to 3000 (this represents the time in mS that the divider IC101, 102 takes to generate a 5.5 interrupt when loss of free tone is detected).

If this test fails check IC103, 104; TR107, 105; LK104 and associated components.

If the four digit number is outside of the given range the display will flash – check LK102, 103 are correct and check IC101, 102 and associated components.

11. Encode Identity

Press the # button and check that a dash runs continuously through the display. Enter digits '04' and check that the display reads the encode identity of the test personality PROM.

If the display flashes the test location in the user personality PROM and does not correspond with that in the test personality PROM, check the following:

(i) The test personality PROM is present, correctly inserted and coded correctly.
(ii) LK106, 107 are correct.

12. Level Detector

Apply 3V DC to SKTB (+ve pin 15, –ve pin 1), turn RV105 fully counter clockwise, press the # button then enter the digits '05'. Check that the display reads 'P'.

An error is indicated by a flashing E:

E1, E2, E3 } Check setting of RV105 and connections.

E4 Check 3V supply to SKTB pin 15 and connections around IC114, 116, R191, 192.

13. LED and Channel Select

Press the # button and enter digits '06'. Check that the display reads '06' and then shows all dashes.

Using the oscilloscope set to read a 5V DC step check that the following lines are switched 'high' and 'low' in turn and that the lamps associated with the functions are lit when the line goes 'high'.

IC111	pin 16	Busy Lamp
IC111	pin 12	Called Lamp
IC111	pin 11	Local Communication Lamp
IC111	pin 10	Out-of-Range Lamp
SKTB	pins 1 – 4	Channel Select Lines
SKTA	pin B	Mic Mute
SKTA	pin M	Squelch

14. Transmit Switching and Audio Gating

Note: To obtain the correct results the following test (a) to (g) must be performed in the order given.

(a) Switch on the AF generator, press the # button and enter digits '07'.

(b) Connect the oscilloscope to the input of the Rx audio gate (IC112 pin 8) and note the signal level. Connnect the oscilloscope to the output of the gate (IC112 pin 9) enter digit '1' and check that the signal level is within 1 db of the input. Enter digit '1' again and check that the signal level drops by at least 35 db.

(c) Connect the oscilloscope to the input of the tones out gate (IC112 pin 2) and enter digit '2'. Note the reading. Connect the oscilloscope to the output of the gate (IC112 pin 1) and check that the signal level is within 2 db of the input. Enter digit '2' again and check that the signal level drops by at least 35 db.

(d) Connect the oscilloscope to the input of the alert tone gate (IC112 pin 11) and note the signal level. Connect the oscilloscope to the output of the gate (IC112 pin 10) enter digit '3' and check that the signal level is within 2 db of the input. Enter digit '3' again and check that the level drops by at least 35 db.

If the test of the alert tone gate fails the following procedure may be used:

Enter digit '7' and connect a suitable AF generator (5V ptp output, 600Ω output impedance) to the input of the gate (IC112 pin 11). Check the attenuation on the output (IC112 pin 10).

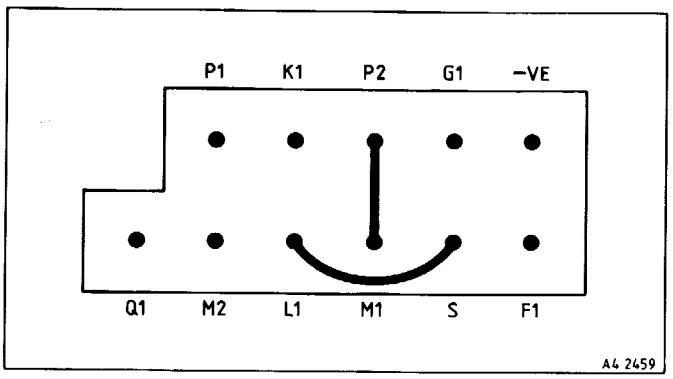
(e) Enter digit '4' and check that the Tx lamp is lit. Enter digit '4' again and check that the lamp is off.

(f) Enter digit '5' and check that the Tx lamp is lit only when the microphone PTT switch is operated.

(g) Enter digit '6' and check that the Tx lamp is permanently off.

TEST PROCEDURE - MOBILE UNIT (MX290 + CX290)

Note: Before carrying out the tests described below, make sure that the link field on the MX290 Series transceiver board is connected as follows:



1. Test Equipment Connections

Using the extender leads connect the MX290 transceiver board and the CX290 control board to the test equipment as shown in Fig. 4.2. Set power supply output to 13,8V DC and current limit to 5A

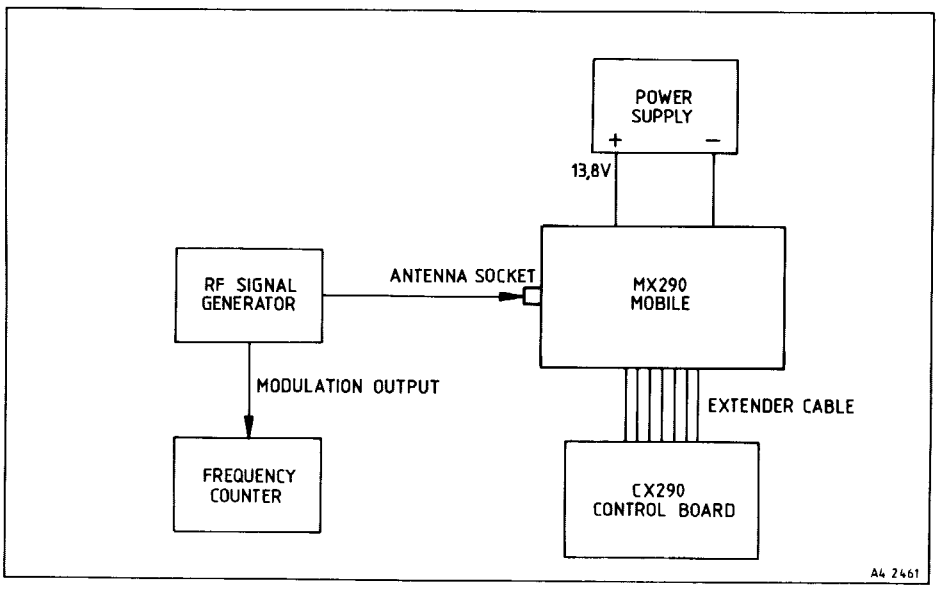


Fig. 4.2 Mobile Unit Test Circuit

2. Test PROM

Insert the test PROM's in the CX290 control board; switch on the power supply and the mobile and check the display reads all eights.

3. Freetone

(a) Set the signal generator output to the receiver test frequency, 1mV PD, modulation - FM (internal). Set the internal modulation frequency to the specified freetone frequency or, if unavailable, to test frequency of 500 Hz. Set the deviation corresponding to this frequency determined from Fig. 4.3.

(b) Press the # button then enter digits '08'. Select any channel on the mobile by entering the channel number in the form '01', '02', '03' etc.

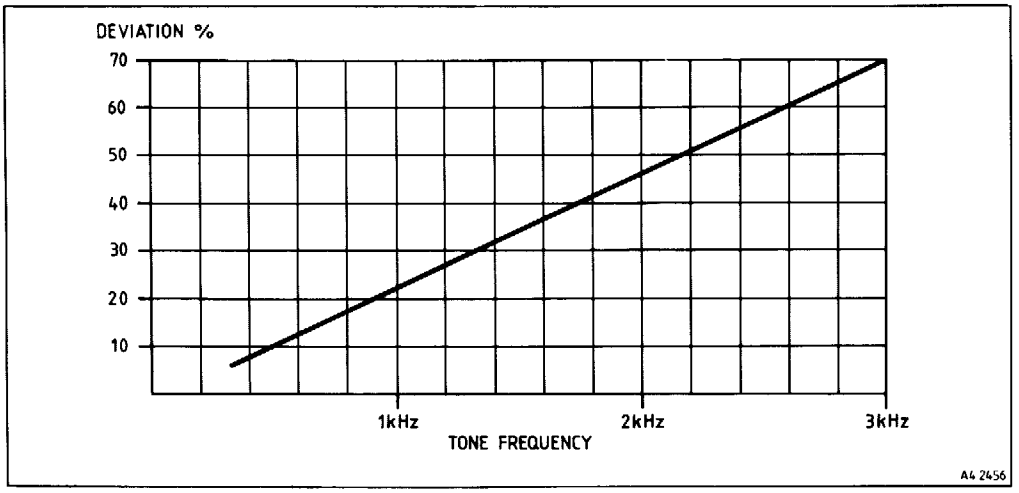


Fig. 4.3 Deviation Graph

(c) Adjust RV102 on the control board to give the following level at TP3.

Less than 0,3V for frequencies within 7,5 Hz of the freetone frequency

Greater than 3,4V for frequencies outside the range of freetone ±17,5 Hz.

(d) Switch off the modulation, press the # button then enter digits '09'. Set RV105 fully counter clockwise.

Set the signal generator output to 1,0μV ±0,5 db, switch off the carrier and check that the 'Out-of-Range' lamp is lit.

Switch on the carrier and adjust RV105 until the 'Out-of-Range' lamp is just lit and the 'Busy' lamp is just off.

Slowly increase the carrier level until the 'Out-of-Range' lamp is off and the 'Busy' lamp is lit. Check that when this occurs the output level is 1,6μV PD (−3 db +1 db). Re-adjust RV105, if necessary, to ensure this.

Switch on the modulation and check that the 'Busy' lamp is off and the channel number is displayed.

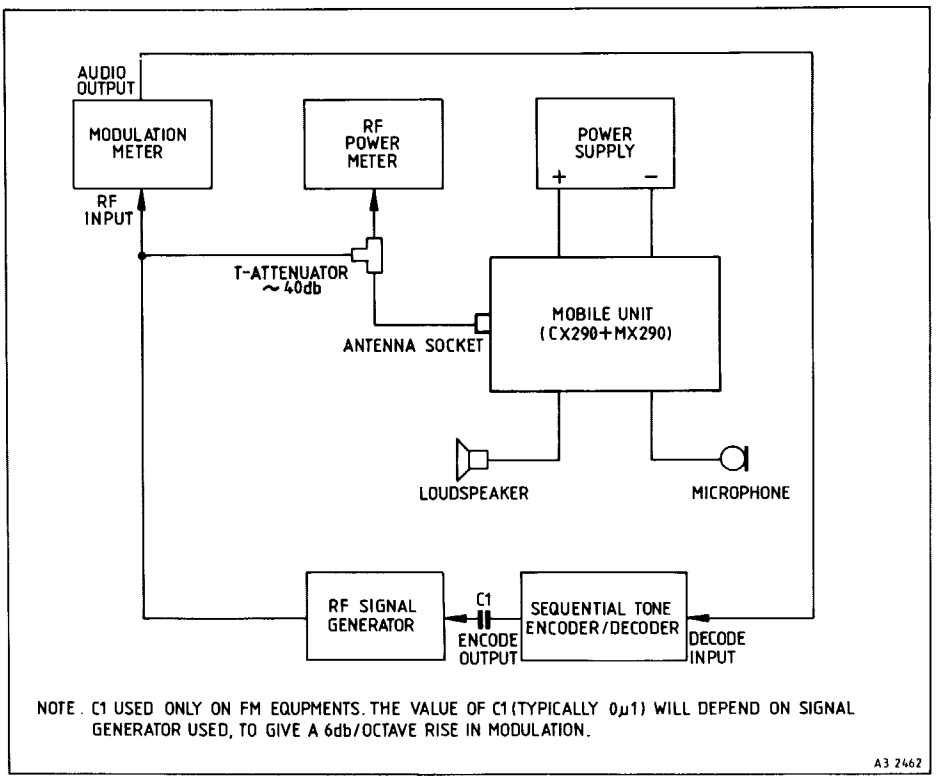


Fig. 4.4 Tone Encode/Decode Test Circuit

4. Tone Encode

(a) Connect the mobile to the test equipment as shown in Fig. 4.4. Switch on.

Set the sequential tone encoder/decoder to EEA, 1% bandwidth, 40 mS timing.

Select any channel as detailed in 3(b) then press the # button followed by digits '01' then digits '1 2 3 4 5'.

(b) Press the local communication button and adjust RV104 until the deviation on the modulation meter corresponds with that determined from Table 4.1 and Fig. 4.3.

Press the * button and check that the sequential tone encoder/decoder decodes 1 2 3 4 and 5.

DIGIT	FREQUENCY
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
0	1981
Repeat	2110
Alarm	2400
Group	1055

Table 4.1 Tone Frequencies

5. Tone Decode

(a) Set the output of the signal generator to 100 mV, modulation - FM (AC external).

Enter digits 6 2 7 8 9 on the sequential tone encoder/decoder; set the deviation, determined from Table 4.1 and Fig. 4.3, using the sequential tone encoder/decoder output level control and the signal generator output control.

(b) Press the * button then enter digits '02'. Send the code from the sequential tone encoder/decoder and check that the mobile display shows the correct code.

Note: (i) To obtain the correct results test 6 and 7 must be performed in the order given.

(ii) Full details of the function of each keypad switch are given on page 4.13.

6. Audio and Tone Gate

(a) Press the * button and enter digits '07'.

Set the output of the signal generator to 1 kHz internal modulation, 1,2 kHz deviation.

Enter digit '1' and check that the audio gate is enabled.

Enter digit '1' again and check that the audio gate is disabled.

(b) Switch off the carrier

Enter digit '3' and check that an alert tone is generated.

Enter digit '3' again and check that the alert tone ceases.

7. Transmitter and Microphone Mute.

(a) Enter digit '4' and check that the transmitter is on, the Tx lamp is lit and modulation is indicated when the microphone is used.

Enter digit '4' again and check that the transmitter and Tx lamp are off.

(b) Enter digit '5' and check that the transmitter is on and the Tx lamp is lit only when the microphone PTT switch is operated, check that no modulation is indicated when the microphone is used.

(c) Enter digit '6' and check that the transmitter and Tx lamp are permanently off.

LINK DETAILS

* *Denotes standard link setting*

Link	Position	Function
101	IN	Control of radio AGC inhibit line by CPU.
102, 103	See Table 4.3	Freetone timeout period = $\frac{M \times N}{fxtal}$
104	* A – B A – C	Gyrator decode mode selected. Gyrator encode mode selected.
105	* A – B A – C	Gyrator encode mode disabled. Gyrator encode mode enabled.
106, 107	See Table 4.4	LET selection
108	Not Used	
109	* OUT IN	Divided output from A/D converter selected.

Table 4.2.

Link	Position	Multiplier	Symbol
102	A – B	524288	
	A – C	1048576	
	A – D	2097152	
	* A – E	4194304	M
	A – F	8388608	
	A – G	16777216	
	A – H	33554432	
103	A – B	Not Used	
	A – C	0,5	
	A – D	1,5	
	*A – E	2,5	
	A – F	3,5	
	A – G	4,5	N
	A – H	5,5	
	A – J	6,5	
	A – K	7,5	
	A – L	8,5	

Table 4.3

LK106	LK107	LET
* A – C	* A – C	150 mS
A – B	A – C	250 mS
A – C	A – B	350 mS

Table 4.4

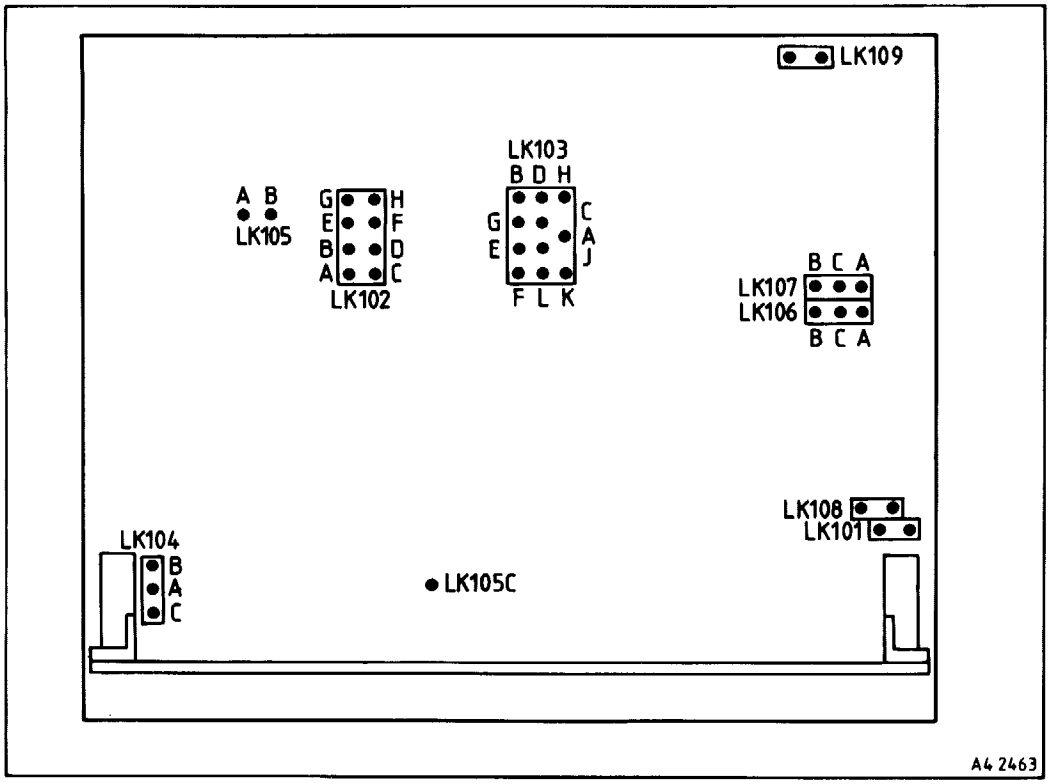


Fig. 4.5 Location of Links

EXPLANATORY NOTES ON FUNCTIONS OF KEYPAD SWITCHES

With the test EPROM fitted on the control board selection of test 07 (press the # button then enter digits '07') enables the keypad switches to be used to test the following functions.

Note: Each switch 'toggles' a single function. ie: Successive pushes of the switch enable and disable the functions.

'1' Switches the received audio gate on and off. If a channel has been set and a modulated carrier is fed to the receiver successive pushes of '1' will enable and disable the loudspeaker

'2' Enables and disables the sequential tone gate.

This function may be tested using an additional mobile (with the local communication channel selected) as a test receiver.

(i) Select the local communication channel on the test receiver.

(ii) Select same frequency channel on mobile under test (Enter digits '08' followed by appropriate channel number '02' to '09').

(iii)

CAUTION
Entering digits '07' followed digit '4' keys the transmitter.

Enable the transmitter of the mobile under test (Enter digits '08' then digit '4').

(iv) Successive presses of '2' on the mobile under test will enable and disable the sequential tone gate which switches on and off a 1 kHz tone heard from the loudspeaker.

'3' Enables and disables the alert tone gate. A low frequency tone is generated to distinguish it from the 1 kHz tone generated in '2'.

'4' Switches the transmitter on and off; microphone mute is not affected.

'5' Ensures the transmitter is off, then enables the microphone press-to-talk switch. Successive presses of '5' will enable and disable the microphone. This function may be tested using the arrangement in '2'; if the sequential tone gate is left open the 1 kHz tone will be heard as well as modulation from the microphone.

'6' Switches off the tone generator preventing generation of alert tones and sequential tones, and disables the microphone press-to-talk switch.

'7' Enables and disables the alert tone gate as in '2', but the tone generator is not switched on. This enables an external AF generator to provide the alert tone and is used for factory test purposes.

FAULT LOCATION

Fault location on the E31 - 300 mobile can be performed on two levels - using the operational (customer) PROM or using the test PROM.

The tests follow a logical progression and should be carried out in the order given to avoid unnecessary work and thus save time.

Fault Diagnosis

When a fault occurs if it is possible to test a mobile within the range of an E31 system the following points may be checked the results of which will facilitate fault diagnosis.

1. Is a channel number displayed? If not, is 'Busy' or 'Out-of-Range' lit? Does an improved 'antenna' give display of a channel number?

2. If Busy is lit when one or more channels are known to be free, has the freetone detector on the control board been set up correctly?

3. If 'Out-of-Range' is lit when mobile is in area of good signal strength and using good antenna, check output from carrier level detector on radiotelephone (SKTB pin 15).

4. Is it possible to enter digits from the keypad and view them on the display? When more than 16 digits are entered is 'piptone' generated on each further key stroke?

5. Dial out to a telephone or another mobile. If 'NU' tune is heard is it locally generated or returned from base?

6. If dialling out is unsuccessful does the transmit indicator come on briefly to indicate that 'Initiate Call' is sent?

7. If dialling out is unsuccessful can the mobile/telephone be called from another mobile or telephone?

8. If the mobile cannot call out or be called via the E31 system is it possible to use the local communication channel?

   Note: The following checks require the equipment cover to be removed.

9. Are two rubber pads fitted to the underside of the control board? If not, the board may foul on the cover. On later versions of the equipment the rubber pads are replaced with plastic studs.

10. If possible, substitute a known working control board in the suspected faulty equipment. This may make it possible to localise the fault to control head or radiotelephone.

11. Is the correct personality PROM fitted?

12. Is a channel actually being set on the radiotelephone? LED1 on the transceiver board will light to indicate this.

Tests Using Operational PROM

1. Check that the total current consumption of the mobile unit (CX290 + MX290) is 700 – 900 m A of which 80 – 100 mA is taken when the display shows all eights.

   If the total current consumption is significantly higher check for a component (especially an IC) which is obviously over-heating.

   Note: Power supply components IC118, R207, R208 get hot during normal operation.

   If the total current consumption is substantially lower check that power is reaching all parts of the board. (ie: Check that each IC has the correct supply voltage).

2. Apply an unmodulated signal of approx. 50μV on one of the scanned channels. Check that 'Busy' lights within 4 seconds.

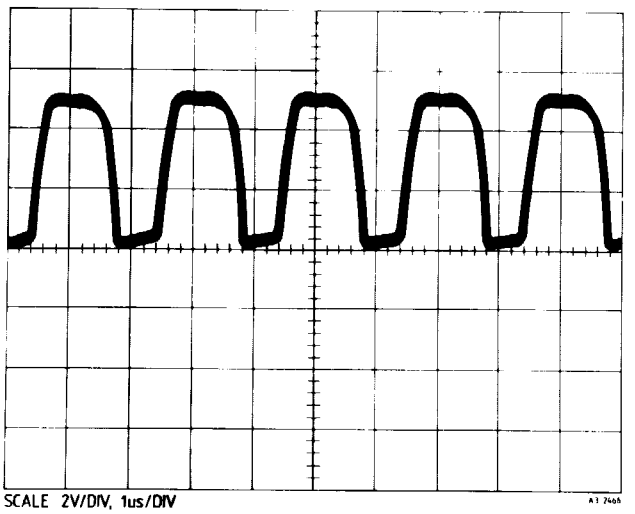
3. Enter a random set of digits from the keypad and check that each appears on the display.

   If any of these tests fail check the following

   (i) If the CX290 is completely non-operational check that $\overline{\text{RESET}}$ on the processor IC105 pin 36 is 'high' (4 – 5V). If this is incorrect check IC104 and associated components.

   (ii) A display reading '09090909' is possibly caused by the PROM missing or inserted incorrectly.

   (iii) Check that the RESET output from the processor IC105 pin 3 is 'low' and is present on all IC's with a RESET input.



   (iv) Check the clock output from the processor IC105 pin 37; this should be a 2,5 MHz square wave, 4 – 5 ptp. Check that this waveform is present on all IC's with a clock input.

   If the waveform is not present on pin 37 check that the input on IC105 pin 1 is a 5 MHz square wave, 2 – 3 V ptp. If this waveform is not present check the crystal X101 and the crystal oscillator TR101, 102 and associated components.

   (v) Inability to set a channel is possibly due to a transceiver fault; check the transceiver PROM, the extender cables, the co-axial link fitted to the underside of the transceiver board, and TR110 – 113 on the control board.

   (vi) Reset the equipment by switching off, then on again. Using an oscilloscope monitor the interrupt request line from the keypad decoder IC120 pin 4, press any digit on the keypad and check that the line goes 'high' then 'low' again.

   Note: The line switches 'high' for only a very short time so this operation will probably need to be repeated several times before the effect is seen.

   If a 'high' pulse is not present check the connections between the keypad and the keypad demultiplexer IC107 pins 9 – 15. If the line remains 'high' the interrupt has not been seen – possibly an addressing fault. Check IC107 pins 1 – 7 and the CLOCK input to IC120 pin 3.

(vii) On earlier versions of the control board (Issues 1 to 3) check that two rubber feet are fitted to the underside of the board to prevent the board fouling on the equipment cover. On later versions of the equipment these are replaced by plastic studs.

(viii) If the keypad is operating correctly check the tone generator — Disconnect the antenna enter one or more random digits from the keypad, press the send button and check there is an audio waveform (as a burst of 'Number Unobtainable' tone) within 4 seconds, at the following points:

TP13; IC117 pins 3, 1, 12, 14 and 8.

(ix) Excessive multiplexer noise from the loudspeaker may indicate a short circuit between two +5V lines; check that the resistance across R208 measures 2,2 ohms (approx.).

4. Connect power meter to the antenna socket and with no signal input check that 'Out-of-Range' is lit.

5. Select the local communication channel and check that the mobile transmits when the microphone PTT switch is operated. If two mobiles are available check that back-to-back communication is possible on the local communication channel and that the power output is 10 - 15W.

6. Disconnect the microphone and power meter and connect the RF signal generator to the antenna socket. Apply a modulated signal on the local communication channel frequency and check that the level required to open the squelch is 0,2 — 0,5μV (approx 12 db SINAD). Any great deviation from this reading may indicate a radiotelephone fault.

7.

CAUTION

Do not operate the send button whilst the RF signal generator is connected to the antenna socket

Revert from the local communication channel to the scanning mode. Check that keypad entries are displayed and that the display is cleared after 15 seconds.

8. Apply an unmodulated signal of approx. 50μV on one of the scanned channels. Check that the 'LOCK' LED on the transceiver board is lit and that the 'Busy' lamp on the front panel of the CX290 lights within 4 seconds.

Reduce the signal input to zero and check that 'Busy' is off and 'Out-of-Range' is lit.

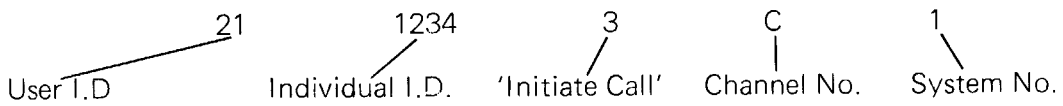
Very slowly increase the signal level until 'Busy' is lit (within 4 seconds). Check that the level required to give a 'busy' indication is 1 — 2μV approx.

If the level required is significantly higher than 2μV check the carrier level detector using the test PROM.

9. With 'Busy' lit switch on the signal generator modulation at freetone frequency with 1,2 kHz deviation. Check that 'Busy' is off and the channel number is displayed.

If this test fails check the freetone detector using the Test PROM.

10. If tests 8 and 9 are successful, it is possible to check that 'Initiate Call' is being sent by the mobile. With a signal on one of the scanned channels, modulated with freetone, and with an attenuator between the signal generator and the mobile, key in any digit, then press the * button and quickly switch off the signal generator (in less than 4 seconds). Ensure that leakage from the generator is not significant. The mobile should transmit 'Initiate Call', which will cause the transmit lamp to light for 0,5 seconds (approx.). The outgoing message may be decoded if a fast deviation meter is available (less than 150 mS LET), feeding into an EEA tone decoder. The message will be of the form:



Tests Using Test PROM

If a test PROM is available some of the test procedures outlined in this section will aid fault location.

Any channel on the mobile is set as follows:

(i) Insert test PROM

(ii) Switch on, wait for 88888888 to be displayed.

(iii) Press # which gives a 'scrolling dash' as a prompt.

(iv) Enter '08' followed by required channel (eg: 01 for channel 1, 04 for channel 4 etc.).

A row of dashes confirms channel is set. Program will then give a 'scrolling dash' prompt, again.

1. Encoding of tones may then be tested by entering '01', followed by a few random digits. With a modulation meter fed with part of the RF power output from the mobile, its audio output connected to an EEA tone decoder, check that the digits decoded correspond with those entered on the mobile. Tones may be checked one at a time by stepping through the sequence using the local communication button. If tones are not correctly decoded, check that deviation corresponds with that shown on graph in Fig. 4.3.

   If it is, set up again according to the test procedures having made sure that transceiver deviation is correct for microphone input.

2. Tone decoding may be checked using test '02'. Feed an EEA sequence of up to 8 tones as audio on SKTA pin E, or modulated onto a carrier on the selected channel. Failure to decode correctly may be due to a faulty ceramic resonator X102 (check the clock frequency on IC106 pin 1 is 23 kHz ±1%) or a faulty FX003 (IC106).

   Remember to select the channel again if for any reason the power to the control board is in interrupted.

3. Tests '04' (Check encode identity), '05' or '09' (different checks on level detector) may be useful. If the encode identity is read incorrectly, and the personality PROM is known to be correct, check that links LK106 and LK107 are correctly set.

4. Carrier Level Detector

   (a) Set any channel on the mobile then enter digits '09'.

   (b) With no signal input check that the 'Out-of-Range' lamp gives a steady indication. If not, adjust RV105 to achieve this.

   (c) If a steady indication cannot be achieved using RV105 check that the voltage on SKTB pin 15 (measured on the AVO 8) is:

      (i) With no signal input -- less than 0,9V DC

      (ii) With 1,6μV signal input – an increase of 0,3V DC and greater than reading (i).

      These measurements may be carried out on the local simplex channel if more convenient.

      If readings (i) and (ii) are not obtainable suspect the carrier level detector on the main transceiver board.

   (d) If the steady indication is present apply an unmodulated signal on the set channel and adjust the input level until the transition between 'Busy' and 'Out-of-Range' is reached. (This is indicated by the 'Busy' and 'Out-of-Range' lamps flashing alternately).

      Check that this transition is reached when the input level is between 1 – 2μV.

   (e) If this input level is incorrect proceed as follows:

      (i) Set the input level to 1,0μV.
      (ii) Adjust RV105 until the 'Out-of-Range' lamp is just lit.
      (iii) Increase the input level until the 'Busy' lamp is just lit. Check that the input level is 1,6μ V (+1 db, –3 db).

      If this measurement is incorrect carry out step (c).

5. Freetone Detector

Apply a signal of 50μV (approx.) modulated with freetone; check that the input to the freetone detector is present on TP1. If the tone input frequency is within the detection bandwidth of the gyrator, the output on TP3 is 'low'.

If not, check:

(i) The signal generator is modulated with the correct freetone frequency.

and

(ii) RV102 is set correctly. It should be possible to view on an oscilloscope connected to TP3 the dip in level from 5V to less than 0,5V when the tone detector locks.

This test may be carried out on the local simplex channel if more convenient.

SECTION 5
PARTS LIST

COMPONENT-VALUE NOTATION

In the following Parts List, component values are designated as follows:

Capacitors Values given in micro-Farads unless otherwise stated.
Fractional values are dealt with as shown below.

e.g.	22 = 22 micro-Farad (F x 10^{-6})	2μ2 = 2,2 micro-Farad = (2,2 x 10^{-6})F
	22n = 22 nano Farad (F x 10^{-9})	2n2 = 2,2 nano Farad = (2,2 x 10^{-9})F
	22p = 22 pico Farad (F x 10^{-12})	2p2 = 2,2 pico Farad = (2,2 x 10^{-12})F

Resistors Values given in Ohms unless otherwise stated.
Fractional values are indicated as shown below.

e.g.	22 = 22 Ohms	2R2 = 2,2 ohms (2,2 x 10^{0})
	22k = 22 kilohms (Ohms x 10^{3})	2k2 = 2,2 kilohms (2,2 x 10^{3})
	22M = 22 Megohms (Ohms x 10^{6})	2M2 = 2,2 Megohms (2,2 x 10^{6})

ORDERING OF SPARE PARTS

When ordering spare parts, please quote:

(i) Component description and part number
(ii) Part number of the sub-assembly on which used (where applicable)
(iii) Equipment code number (given on identity label fixed to rear panel)

*NOTE: **The right is reserved to fit alternative types of semiconductor or integrated circuits having equal or improved performance to those quoted.***

ABBREVIATIONS

The following abbreviations may be found in this Parts List:

Assy	= assembly	Hex	= Hexagonal	Reg	= Regulator
				RH	= Right Hand
cad	= cadmium	I/O	= Input/Output	Rx	= Receiver
cer	= ceramic	int	= internal		
chan	= channel	Intf	= interface	SOT	= Select-on-Test
c h	= cheese-head			S/T	= Self-tapping
csk	= countersunk	LED	= Light Emitting Diode	Sdriv	= Supadrive
c/w	= complete with	LH	= Left Hand	SIL	= Single-In-Line
c.film	= carbon film	log	= logarithmic		
		LS	= Loudspeaker	Tant	= Tantalum
DIL	= Dual In-Line			tub	= tubular
Dist	= Distribution	m.film	= metal film		
				w w	= Wire Wound
elect	= electrolytic	Ops	= Operators		
ext	= external				
		pan	= Pan head		
f/th	= feedthrough	Poly	= Polyester		
		Polyp	= Polyprop		
		Polyst	= Polystyrene		
		Pot	= Potentiometer		
		pozi	= Pozidrive		
		PCB	= Printed Circuit Board		
		PWR	= Power		

Cct Ref	Description	Part No.
MOBILE CONTROL UNIT, CX290		
Miscellaneous		
–	PCB, Control	AT28834
–	PCB, Front Panel	AT28835
*IC109	EPROM, programmed	AT60019
*IC113	Personality PROM, programmed	AT60032
–	Location Spigot (2 off)	BT29958
PCB, CONTROL		**AT28834**
Sub-Assemblies		
–	PCB, IC Phantom	AT28877
–	PCB, Interconnection	AT28836
Semiconductors & IC'S		
IC101-104	Part of AT28877	
IC105	Microprocessor	FU08029
IC106	ICQTC Tone Decoder	FU02387
IC107	ICMC74 HC139N	FU07717
IC108	ICMC74 HC373N	FU07723
IC109	Part of AT28877 – See above*	
IC110	I/O RAM Timer/Counter	FU08030
IC111	IC High Voltage/High Current	FU99704
IC112	Part of AT28877	
IC113	Personality PROM – See above*	
IC114	Part of AT28877	
IC115	I/O RAM Timer/Counter	FU08030
IC116	Part of AT28877	
IC117	Part of AT28877	
IC118	IC7805	FU99110
IC119	Not Used	
IC120	IC Keyword	FU99302
IC121	ICNE 591N	FU09738
IC122	ICNE 587N	FU09737
TR101-104	Transistor ZTX108C	FV05875
TR105	Transistor BF245B	FV05900
TR106-109	Transistor ZTX108C	FV05875
TR110-115	Transistor ZTX213	FV05879
TR116-118	Transistor ZTX108C	FV05875
D101	Zener Diode 2V7	FV05894
D102	Diode 1N4148	FV05808
D103	Zener Diode 4V7	FV05866
D104-115	Diode 1N4148	FV05808
D116	Diode BAT85	FV05638
Resistors		
R101	22k ±5% 0,25W c.film	PM01452
R102	22k ±5% 0,25W c.film	PM01452
R103	100 ±5% 0,25W c.film	PM01424
R104	1k ±5% 0,25W c.film	PM01436
R105	100 ±5% 0,25W c.film	PM01424
R106	33k ±5% 0,25W c.film	PM01454
R107	33k ±5% 0,25W c.film	PM01454
R108	1k ±5% 0,25W c.film	PM01436
R109	Not Used	
R110-113	100k ±5% 0,25W c.film	PM01460
R114	180k ±5% 0,25W c.film	PM01463
R115	100k ±1% 0,25W m.film	PL99110
R116	Not Used	
R117	390k ±5% 0,25W c.film	PM01467
R118	390k ±5% 0,25W c.film	PM01467
R119	100k ±5% 0,25W c.film	PM01460
R120	100k ±5% 0,25W c.film	PM01460
R121	68k ±5% 0,25W c.film	PM01458
R122	10k ±5% 0,25W c.film	PM01448
R123	560 ±5% 0,25W c.film	PM01433
R124	100k ±5% 0,25W c.film	PM01460
R125	100k ±5% 0,25W c.film	PM01460
R126	1k8 ±5% 0,25W c.film	PM01439
R127	100k ±5% 0,25W c.film	PM01460
R128	10k ±5% 0,25W c.film	PM01448
R129	10k ±5% 0,25W c.film	PM01448
R130	1k ±5% 0,25W c.film	PM01436
R131	15k ±5% 0,25W c.film	PM01450
R132	8k2 ±5% 0,25W c.film	PM01447
R133	1M ±5% 0,25W c.film	PM01472
R134	100k ±5% 0,25W c.film	PM01460
R135	1k ±5% 0,25W c.film	PM01436
R136	100k ±5% 0,25W c.film	PM01460
R137	100k ±5% 0,25W c.film	PM01460
R138	10k ±5% 0,25W c.film	PM01448
R139	220k ±5% 0,25W c.film	PM01464
R140	220k ±5% 0,25W c.film	PM01464
R141	10k ±5% 0,25W c.film	PM01448
R142	15k ±5% 0,25W c.film	PM01450
R143	10k ±5% 0,25W c.film	PM01448
R144	10k ±5% 0,25W c.film	PM01448
R145	33k ±5% 0,25W c.film	PM01454
R146	1M ±5% 0,25W c.film	PM01472
R147	1M ±5% 0,25W c.film	PM01472
R148	Not Used	
R149-157	10k ±5% 0,25W c.film	PM01448
R153A	10k ±5% 0,25W c.film	PM01448
R158-161	470 ±5% 0,25W c.film	PM01432
R162	100k ±5% 0,25W c.film	PM01460
R163	100k ±5% 0,25W c.film	PM01460
R164-169	10k ±5% 0,25W c.film	PM01448
R170	1k ±5% 0,25W c.film	PM01436
R171	1k ±5% 0,25W c.film	PM01436
R172-175	100k ±5% 0,25W c.film	PM01460
R176	10k ±5% 0,25W c.film	PM01448
R177	1M ±5% 0,25W c.film	PM01472
R178	10k ±5% 0,25W c.film	PM01448
R179	10k ±5% 0,25W c.film	PM01448
R180	1M ±5% 0,25W c.film	PM01472
R181	1M ±5% 0,25W c.film	PM01472
R182	10k ±5% 0,25W c.film	PM01448
R183	680 ±5% 0,25W c.film	PM01434
R184	10 ±5% 0,25W c.film	PM01412
R185	680 ±5% 0,25W c.film	PM01434
R186	7k5 ±2% 0,25W m.film	PM99303
R187	20k ±2% 0,25W m.film	PM99313
R188	15k ±2% 0,25W m.film	PM99310
R189	39k ±2% 0,25W m.film	PM99320
R190	27k ±2% 0,25W m.film	PM99316
R191	10k ±5% 0,25W c.film	PM01448
R192	10k ±5% 0,25W c.film	PM01448
R193	2k2 ±5% 0,25W c.film	PM01440
R194	1k ±5% 0,25W c.film	PM01436
R195	1k ±5% 0,25W c.film	PM01436
R196-199	10k ±5% 0,25W c.film	PM01448
R200	56k ±2% 0,25W m.film	PM99324
R201	47k ±2% 0,25W m.film	PM99322
R202	30k ±2% 0,25W m.film	PM99317
R203	9k1 ±2% 0,25W m.film	PM99305
R204	11k ±2% 0,25W m.film	PM99307
R205	18k ±2% 0,25W m.film	PM99312
R206	10k ±5% 0,25W c.film	PM01448
R207	8R2 ±5% 6W w w	PM01211
R208	2R2 ±5% 2,5W w w	PM01106
R209	27k ±5% 0,25W c.film	PM01453
R210-212	10k ±5% 0,25W c.film	PM01448
R213	15k ±5% 0,25W c.film	PM01450
R214	15k ±5% 0,25W c.film	PM01450
R215	Not Used	
R216	10k ±5% 0,25W c.film	PM01448
R217	820 ±5% 0,25W c.film	PM01435
R218	27k ±5% 0,25W c.film	PM01452
R219	Not Used	
R220	1k ±5% 0,25W c.film	PM01436
R221	1k ±5% 0,25W c.film	PM01436

Cct Ref	Description	Part No.
Resistors (Contd.)		
RV101	Pot 10k ±20% lin	PL99689
RV102	Pot 100k ±20% lin	PL99692
RV103	Pot 10k ±20% lin	PL99689
RV104	Pot 10k ±20% lin	PL99689
RV105	Pot 1k ±20% lin	PL99687
RN1	10k ladder network	RN99116
RN2	10k ±5% SIL 9 pin	RN99528
Capacitors		
C101	100n ±10% 63V poly	PQ99511
C102	39p ± 2% 63V cer plate	PN99800
C103	180p ± 2% 63V cer plate	PN99795
C104	180p ± 2% 63V cer plate	PN99795
C105	100n ±10% 63V poly	PQ99511
C106	100n ±10% 63V poly	PQ99511
C107	1µ 50V elect	PS99869
C108	6n8 ± 1% 160V PS	PQ22552
C109	6n8 ± 1% 160V PS	PQ22552
C110	0µ1 50V elect	PS99863
C111	4n7 ±20% cer plate	PN99919
C112	1µ 50V elect	PS99869
C113	100n ±10% 63V poly	PQ99511
C114	100n ±10% 63V poly	PQ99511
C115	4n7 ±20% cer plate	PN99919
C116	100n ±10% 63V poly	PQ99511
C117	1µ 50V elect	PS99869
C118	1µ 50V elect	PS99869
C119	47µ 6V3 elect	PS99851
C120	1n ±20% cer plate	PN99915
C121	100p ± 2% 63V cer plate	PN99805
C122	100p ± 2% 63V cer plate	PN99805
C123-126	100n ±10% 63V poly	PQ99511
C127-131	1µ 50V elect	PS99869
C130A	100n ±10% 63V poly	PQ99511
C132	100n ±10% 63V poly	PQ99511
C133	100n ±10% 63V poly	PQ99511
C134	22n ± 5% 25V cerm	PN99734
C135	680p ± 5% 100V cer plate	PN24363
C136	4n7 ± 5% 100V cer plate	PN41345
C137	2n2 ± 5% 100V cer plate	PN34328
C138	1000µ/20% 16V elect	PS51156
C139	100n ±10% 63V poly	PQ99511
C140	2200µ/20% 10V elect	PS53467
C141	2µ2 50V elect	PS99871
C142	470p ±20% cer plate	PN99933
C143-146	100n ±10% 63V poly	PQ99511
C147	100n ±20% cer plate	PN99927
Miscellaneous		
SKA	Socket 24 pin (For IC109)	FS40893
SKB	Socket 18 pin (For IC113)	FS40892
–	Plug PCB Mtd 2 x 2	FP99172
–	Plug PCB Mtd 2 x 17	FP99188
–	Heatsink	BT45127
–	Label, Serial No.	BT37411
–	Label, CX290	BT37426/01
–	Spacer Logic Module	BT27180
–	Bracket LH	BT11375
–	Bracket Fixing RH	BT11301/01
SKA	Socket 24 pin (For IC109)	FS40893
–	Bracket	BT11376
	Knob on/off	BT37483
X101	Crystal, 5 MHz	FC03189/01
X102	Ceramic Resonator, 560 kHz	FC06159
–	Header 6 position	FC00837/06
–	Screw sdriv st pan M2,5 x 5 mm	QJ11944/B
–	Screw pozi st pan M3 x 8 mm	QJ11902/X
–	Screw sdriv st pan M3 x 10 mm	QJ11903/X
–	Nut hex st M2,5	QA11604/B
–	Nut hex st M3	QA11605/X
–	Washer st M3	QA15005/X

Cct Ref	Description	Part No.
PCB, IC PHANTOM		**AT28877**
IC101	IC HEF 4521BT	FU01080
IC102	IC HEF 4017BT	FU01078
IC103	IC Gyrator	FU01059
IC104	IC Op Amp	FU99804/SM
IC112	IC HEF 4066BT	FU01079
IC114	IC HEF 4066BT	FU01079
IC116	IC Op Amp	FU99804/SM
IC117	IC Op Amp	FU99804/SM
IC119	IC HEF 4017BT	FU01078
PCB, INTERCONNECTION		**AT28836**
Capacitors		
C1-4	1n ±10% 63V cer plate	PN99811
C5	4n7 ±20% cer plate	PN99919
C6-18	1n ±10% 63V cer plate	PN99811
Connectors		
SKTA	Connector Double Row 8 posn	FC00840
SKTB	Connector Vertical 2 x 10 posn	FC06302
–	Connector, Edge	FC00841
PCB, FRONT PANEL		**AT28835**
Miscellaneous		
–	Cable Assembly, Ribbon	AT36877
–	Lead Assembly, Screened	AT36878
–	Knob, Volume	BJ30893/01
–	Tile, On/Off	BJ30894/01
–	Tile, Volume	BJ30895/01
–	Windown, 7 segment	BJ30896/01
–	Tile, Keypad	BT29021
–	Shroud, 7 segment	BT29976
–	Escutcheon Front	BT35285
–	Button Key Switch	BT36578
–	Button Keypad	BT36579/01
–	Button Keypad	BT36579/02
–	Button Keypad	BT36579/03
–	Button Keypad	BT36579/04
–	Button Keypad	BT36579/05
–	Button Keypad	BT36579/06
–	Button Keypad	BT36579/07
–	Button Keypad	BT36579/08
–	Button Keypad	BT36579/09
–	Button Keypad	BT36579/10
–	Button Keypad	BT36579/11
–	Button Keypad	BT36579/12
–	Light Pipe	BT37265
–	Light Pipe, Keypad	BT37266
–	Holder LED	BT45126
SW301-314	Switch Keyboard	FS50916
LED301	LED, Rect, Green	FV05863
LED302	LED, Rect, Yellow	FV05965
LED303	LED, Rect, Red	FV05964
LED304	LED, Rect, Red	FV05964
LED305	LED, Rect, Green	FV05963
LED307 to 312	LED, Rect, Yellow	FV40841
DD301 to 308	LED Display, 1 Digit	FV04838
R301-304	470 ±5% 0,25W c.film	PM01432
R305	8k2 ±5% 0,25W c.film	PM01447
R306	470 ±5% 0,25W c.film	PM01432
R307	1k +5% 0,25W c.film	PM01436
R308	270 ±5% 0,5W carbon	PM00034
R309	270 ±5% 0,5W carbon	PM00034
RV301	Pot 5k ±20% log	PL09220
–	Screw pozi pan st M2 x 6 mm	QJ11992/X

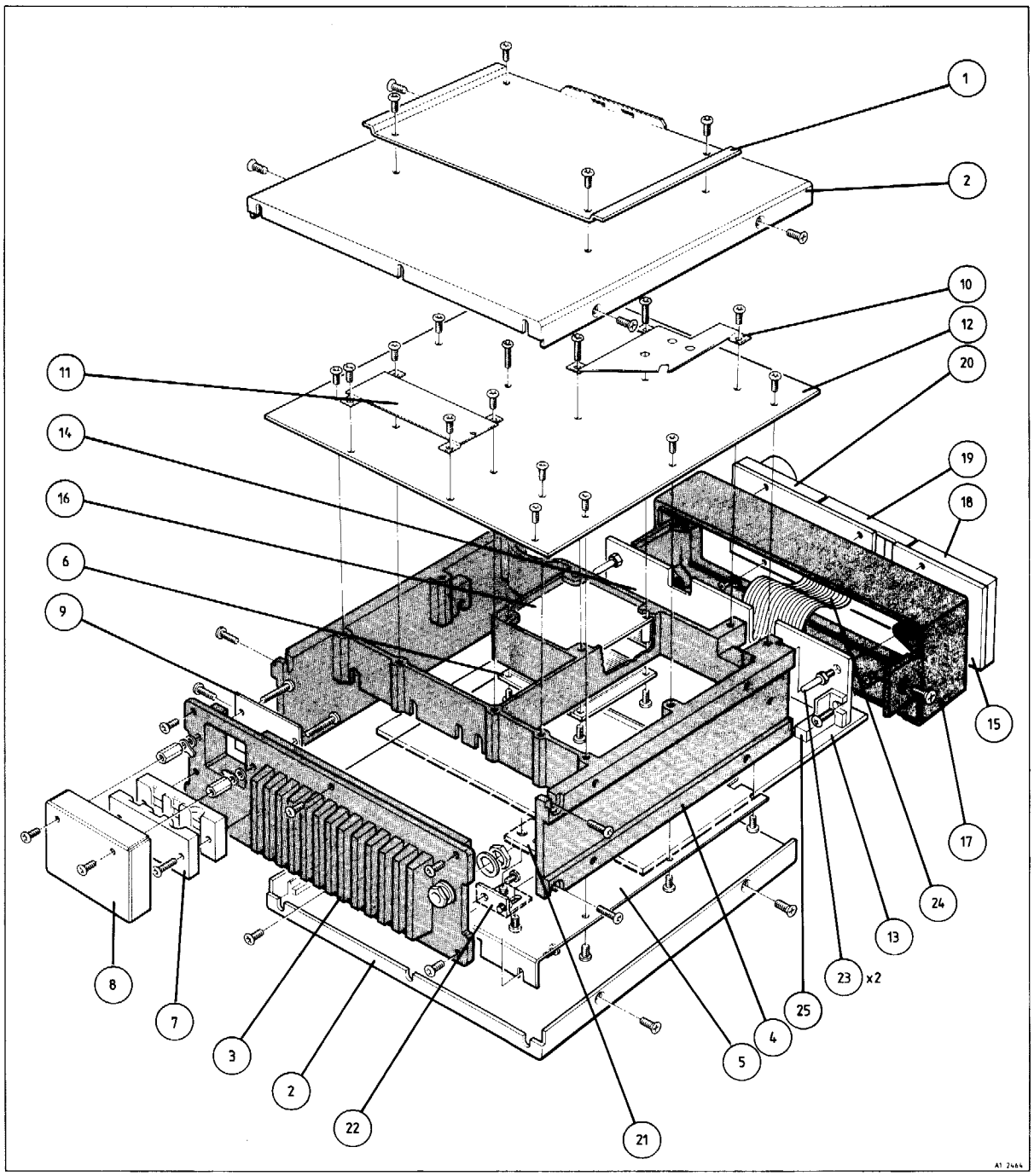
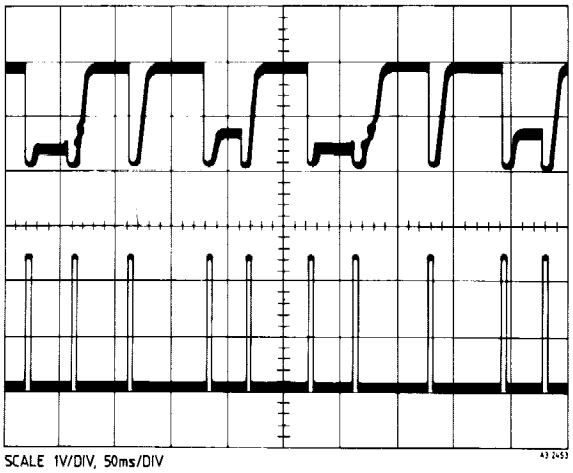


Fig. 5.1 Exploded View

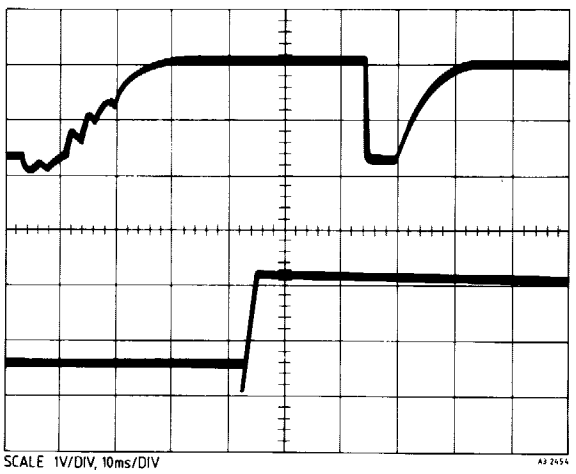
Item Index

1. Carrier Plate
2. Cover
3. Rear Panel
4. Diecast Frame
5. Screen Plate
6. VCO Lid
7. Cable Clamp and
8. Cover
9. Feedthrough Plate
10. Mixer Screen
11. Power Amp Screen
12. Transceiver Board
13. Control Board
14. Interconnection Board
15. Front Panel Board
16. VCO Board
17. Escutcheon Front
18. Tile, Keypad
19. Tile, On/Off
20. Tile, Volume
21. Heatsink
22. Heatsink Bracket
23. Location Spigot
24. Ribbon Cable Assembly
25. Fixing Bracket



Upper Trace: Filtered carrier level detector voltage at IC116(b) pin 5.
Obtained by allowing mobile to scan 4 receiver channels.
No carrier on channel 2 is shown by the smallest peak. The second smallest peak is due to the switched reference level signal gated on to pin 5.
The other peaks are strong signals on the remaining 3 channels.

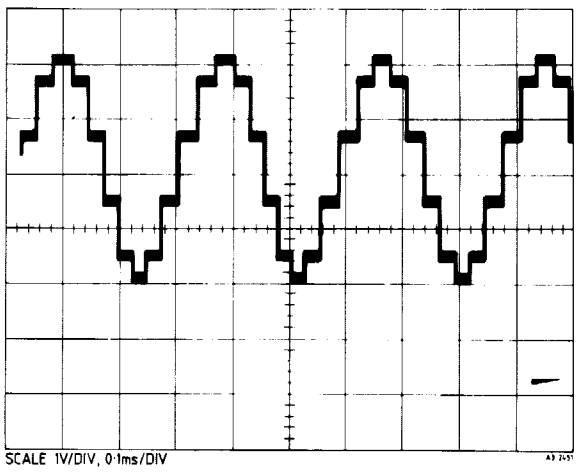
Lower Trace: Gating signal on IC114(d) pin 12. This signal opens gate IC114(d) grounding pin 5 of IC116(b) between carrier level detector voltage measurements.



Upper Trace: Filtered signal from carrier level detector at IC116(b) pin 5.

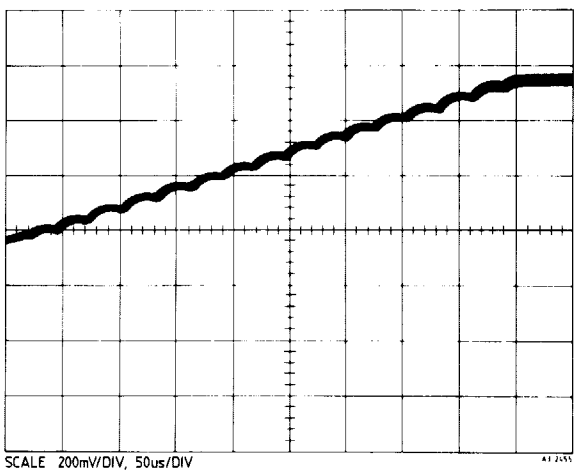
Lower Trace: Corresponding output of R/2R network at IC116(b) pin 6.

Note: Carrier level detector output is allowed to reach final value before R/2R network output voltage is ramped to equal it.



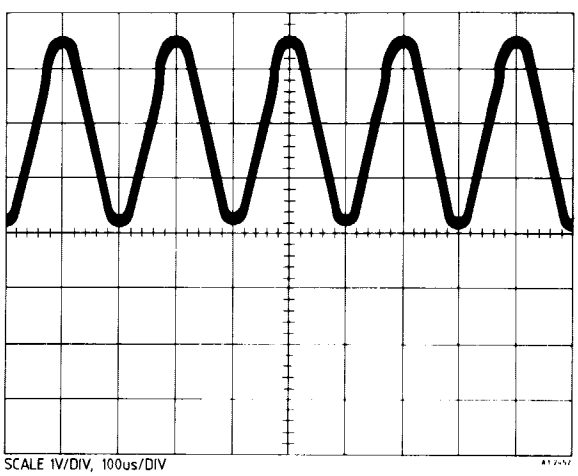
Output from tone synthesis circuit at IC117(a) pin 1

Note: The waveform is a 10 level quantised sinewave approximation with a 5V DC bias.



Small section of ramp output voltage at IC116(b) pin 6

Note: The step shape of the waveform; each step approx. 50 mV.



Crystal oscillator drive output at IC105 pin 1

Note: 0V is mid screen.
Output is approximate sinewave to reduce harmonic radiation from clock input line.

FIG. 6.1 WAVEFORM ANALYSIS

CONTROL BOARD – TRANSCEIVER BOARD CONNECTION INFORMATION

SKTA	DESIGNATION	CIRCUIT ABBREVIATION
A1, A2	0V connection, earth	0V
B	Active open collector output provides mic mute	MIC MUTE
C	Audio inband tone output to Tx	IN BAND TX ENC.
D	Sub-audio tone (CTCSS) output to Tx	SUB AUDIO TX ENC.
E	Unsquelched Rx audio input to tone decoders	RX AUDIO DEC.
F	Squelched Rx audio input for control gating	RX SQ AUDIO
G	Not Used	
H	10V supply for audio circuits	10V
J	10V Tx switched supply for Tx LED	TX 10V
K	10V input from PTT switch (active 'high')	10V PTT
L	10V output key Tx (active 'high')	KEY TX
M	Input squelch line (carrier present 'low')	SQUELCH
N	13,2V unregulated supply to 5V logic regulator	13,2V UNREG
P, Q	Not Used	

SKTB	DESIGNATION	CIRCUIT ABBREVIATION
1		CH CONT LINE 2^3
2	Lower channel control lines	CH CONT LINE 2^2
3	Open collector output to 0V	CH CONT LINE 2^1
4		CH CONT LINE 2^0
5 – 11	Not Used	
12	Output to Rx audio amp	RX AF AMP
13	Undedicated, connected to PC1 (IC115)	UND (IC115)
14	Undedicated, open collector drive output to 0V	UND (0V)
15	Input from carrier level detector board	CLD
16	Not Used	
17		CH CONT LINE 2^7
18	Upper channel control lines	CH CONT LINE 2^6
19	Connected to 0V	CH CONT LINE 2^5
20		CH CONT LINE 2^4

COMPONENT LOCATION – GRID REFERENCE

CONTROL BOARD AT28834

RESISTORS

Code	Location
R101	5H
R102	5H
R103	5H
R104	5H
R105	5H
R106	6H
R107	6H
R108	6H
R109	Not Used
R110	10H
R111	9H
R112	2G
R113	2G
R114	2G
R115	1E
R116	1E
R117	2C
R118	2C
R119	1C
R120	2D
R121	2D
R122	2C
R123	1E
R124	1E
R125	1E
R126	1E
R127	2E
R128	2F
R129	2F
R130	1G
R131	1F
R132	1F
R133	1F
R134	2G
R135	2F
R136	2F
R137	2G
R138	2G
R139	2D
R140	2D
R141	3D
R142	2E
R143	2E
R144	3F
R145	2F
R146	3B
R147	3D
R148	6H
R149	4D
R150	4D
R151	9F
R152	9H
R153	6B
R154	6B
R155	6B
R156	5B
R157	5B
R158	6A
R159	5A
R160	5A
R161	5A
R162	4D
R163	4D
R164	6B
R165	6B
R166	5B
R167	5B
R168	5A
R169	4B
R170	4B
R171	4B
R172	1A
R173	2B
R174	3B
R175	2B
R176	3B
R177	2B
R178	3B
R179	3B
R180	3B
R181	2B
R182	3B
R183	3B
R184	3B
R185	2E
R186	3E
R187	2E
R188	3E
R189	3D
R190	3F
R191	9H
R192	9H
R193	9F
R194	9G
R195	9G
R196	9G
R197	9G
R198	9G
R199	4D
R200	3F
R201	4F
R202	4F
R203	4F
R204	4F
R205	4F
R206	9E
R207	2H
R208	3H
R209	10C
R210	10H
R211	10G
R212	4E
R213	4E
R214	4E
R215	Not Used
R216	2F
R217	7B
R218	9H
R219	2E
R220	3E
R221	3E
R153A	4D
RV101	2E
RV102	1E
RV103	2D
RV104	3A
RV105	10F
RN1	9H
RN2	9F

CAPACITORS

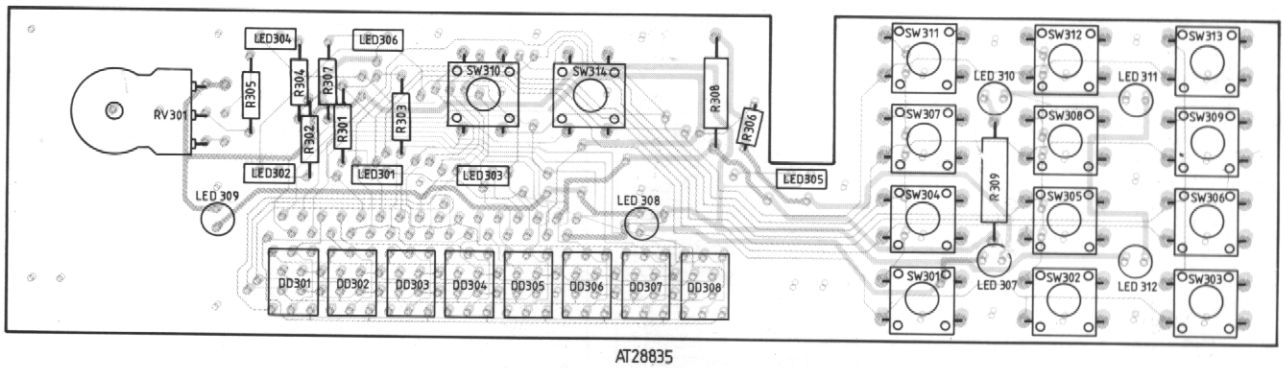
Code	Location
C101	5H
C102	5H
C103	5H
C104	5H
C105	6H
C106	6H
C107	2E
C108	1D
C109	1D
C110	2B
C111	2C
C112	1F
C113	2E
C114	2D
C115	2D
C116	3D
C117	2E
C118	2G
C119	2E
C120	2F
C121	3D
C122	3D
C123	9H
C124	7E
C125	6B
C126	9H
C127	2A
C128	2A
C129	2A
C130	3A
C131	3A
C132	7D
C133	9F
C134	2E
C135	3E
C136	3E
C137	3D
C138	2G
C139	3H
C140	7A
C141	9G
C142	9G
C143	9A
C144	9B
C145	7B
C146	4E
C147	4G
C130A	4B

SEMICONDUCTORS & IC'S

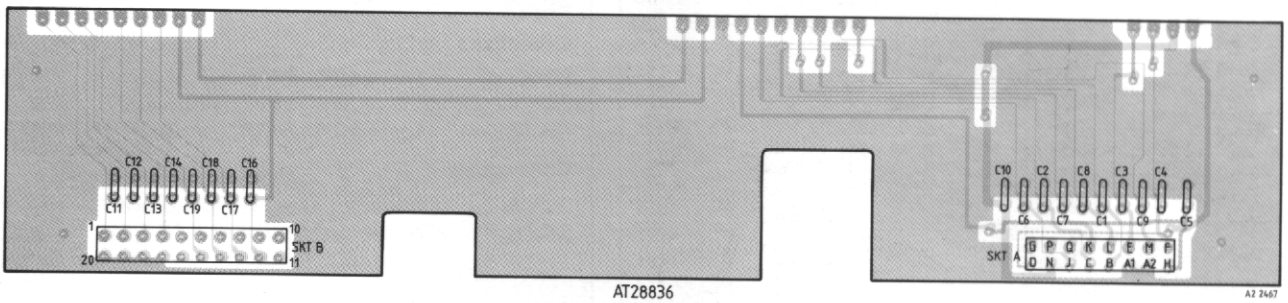
Code	Location
IC101	4F
IC102	5F
IC103	1C
IC104	2F
IC105	7G
IC106	3C
IC107	9D
IC108	5E
IC109	5D
IC110	5C
IC111	4B
IC112	2B
IC113	9E
IC114	9F
IC115	8G
IC116	9H
IC117	3E
IC118	4H
IC119	4E
IC120	8C
IC121	9B
IC122	7B
TR101	5H
TR102	6H
TR103	10H
TR104	2G
TR105	2D
TR106	2F
TR107	2D
TR108	2G
TR109	4D
TR110	6B
TR111	5B
TR112	5B
TR113	5B
TR114	5B
TR115	4A
TR116	2B
TR117	9G
TR118	4D
D101	1G
D102	2F
D103	2G
D104	4E
D105	3E
D106	3E
D107	4E
D108	4E
D109	4E
D110	4E
D111	4E
D112	4E
D113	4E
D114	2B
D115	2B
D116	Not Used

MISCELLANEOUS

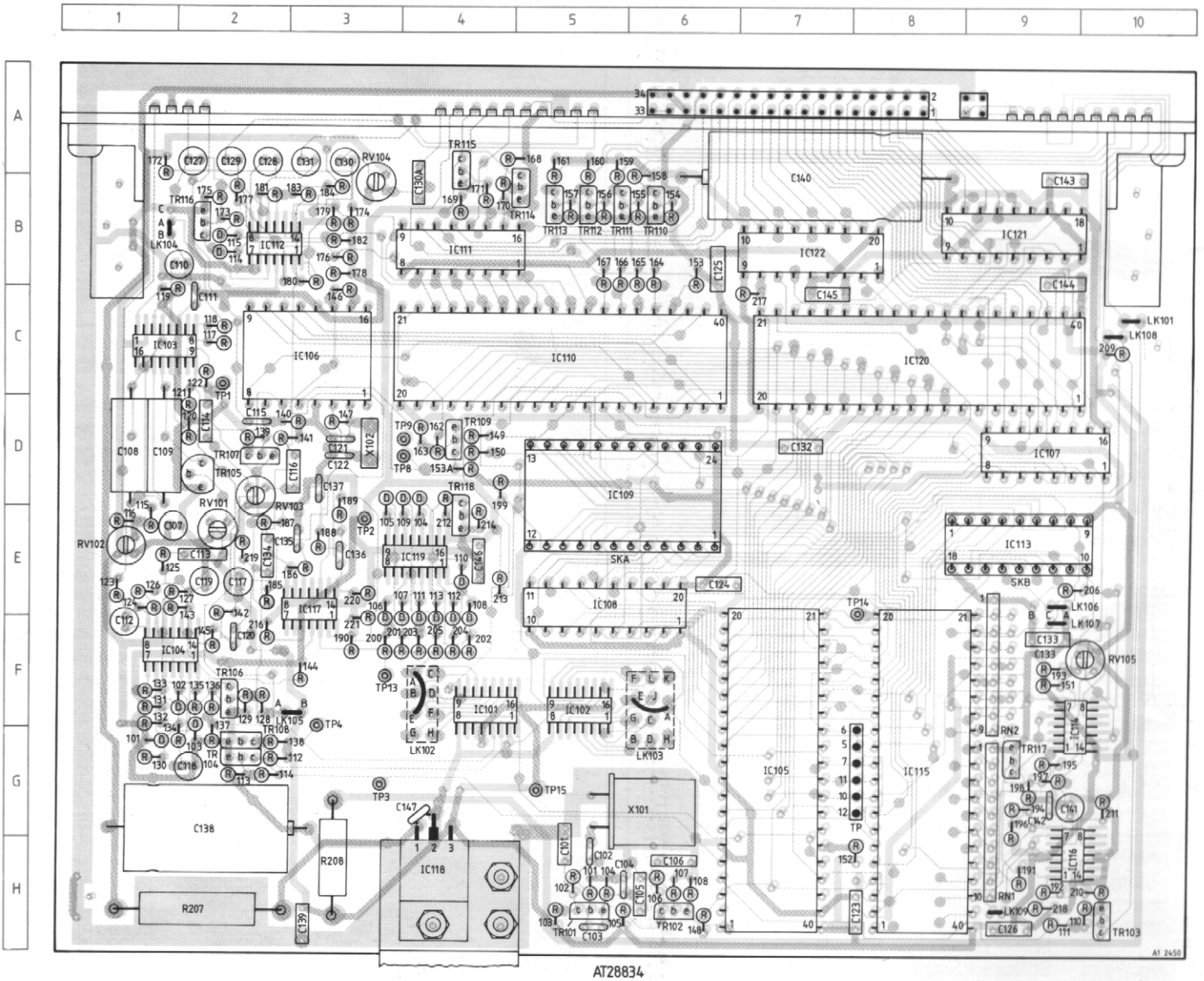
X101	6G
X102	3D
LK101	10C
LK102	4F
LK103	6F
LK104	1B
LK105	3F
LK106	9E
LK107	10E
LK108	10C
LK109	9H
TP1	2C
TP2	3E
TP3	3G
TP4	3F
TP5	8G
TP6	8G
TP7	8G
TP8	4D
TP9	4D
TP10	8G
TP11	8G
TP12	8G
TP13	3F
TP14	8E
TP15	5G
SKA	5D
SKB	9E



AT28835



AT28836



AT28834

FIG. 6.2 FRONT PANEL BOARD AT28835
INTERCONNECTION BOARD AT28836
CONTROL BOARD AT28834
COMPONENT LOCATION

TP223/1

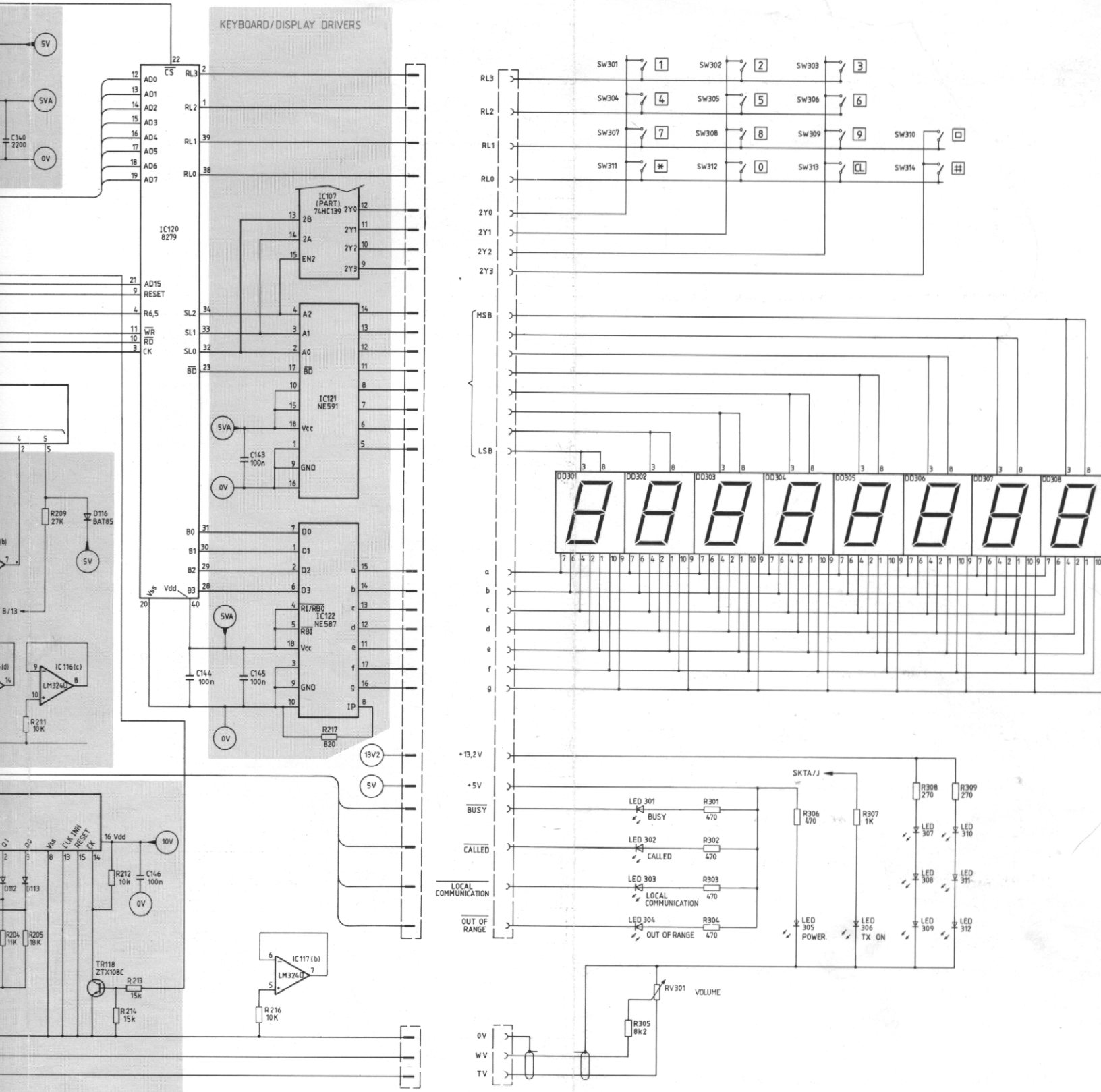
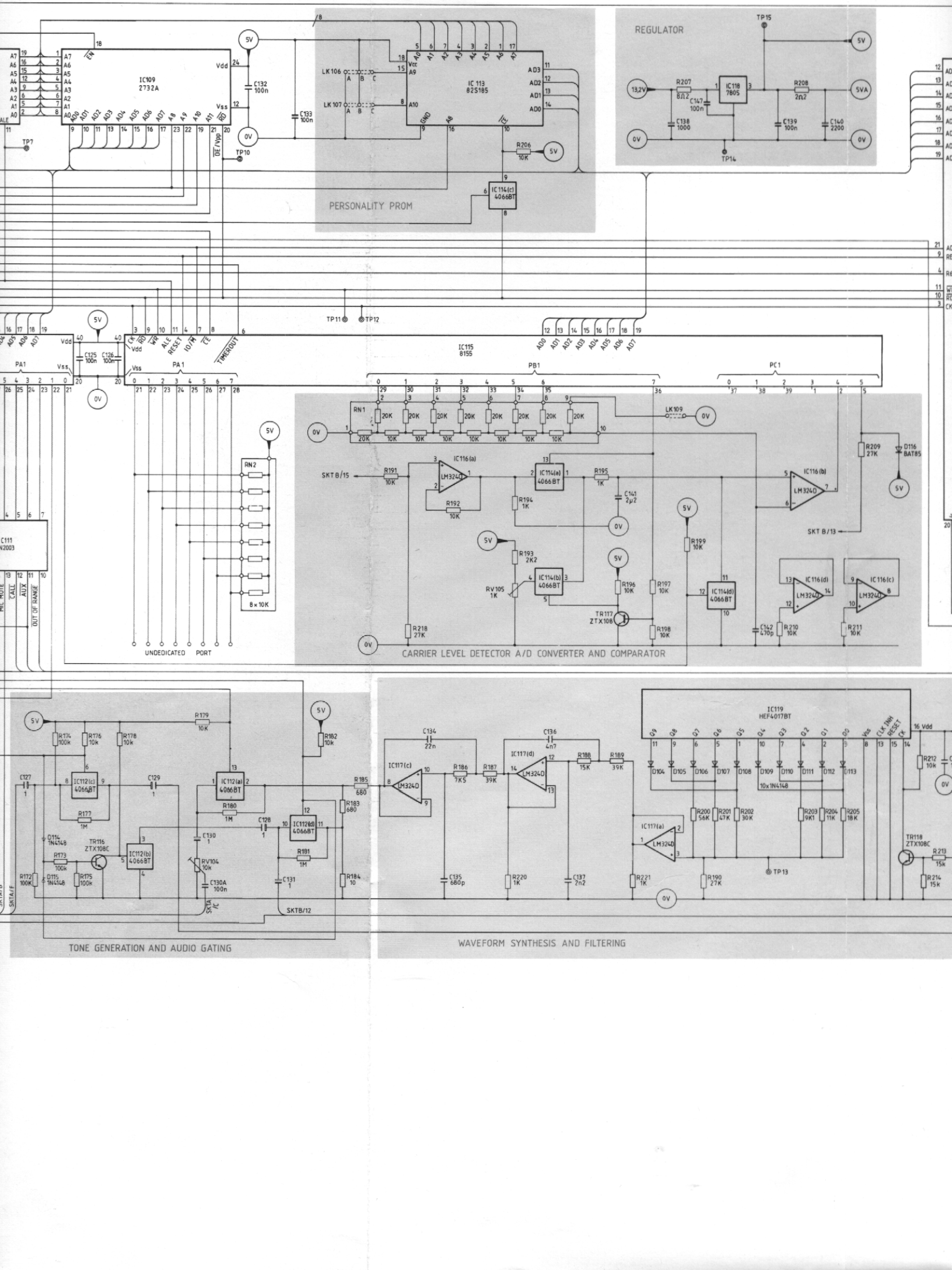
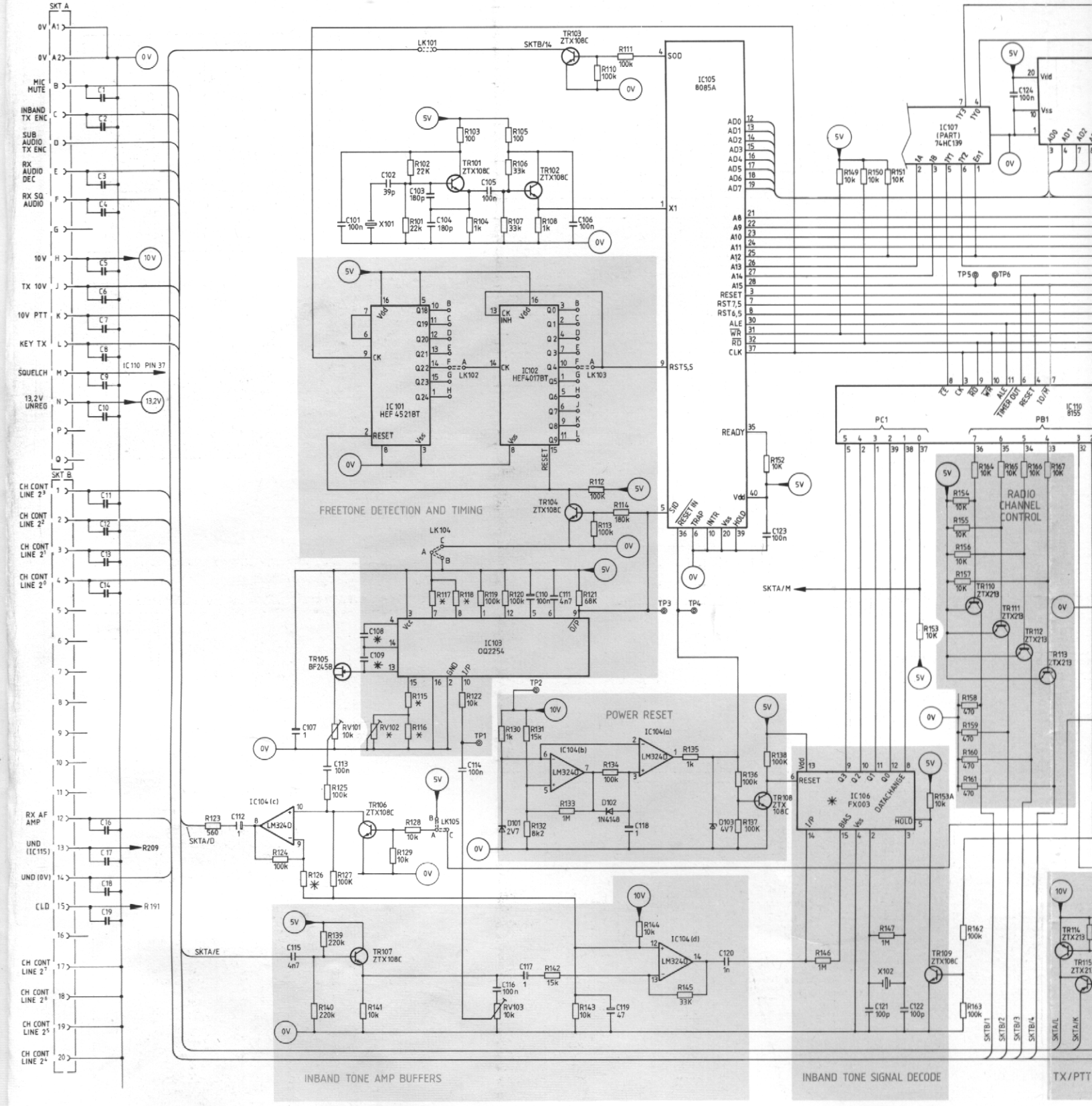
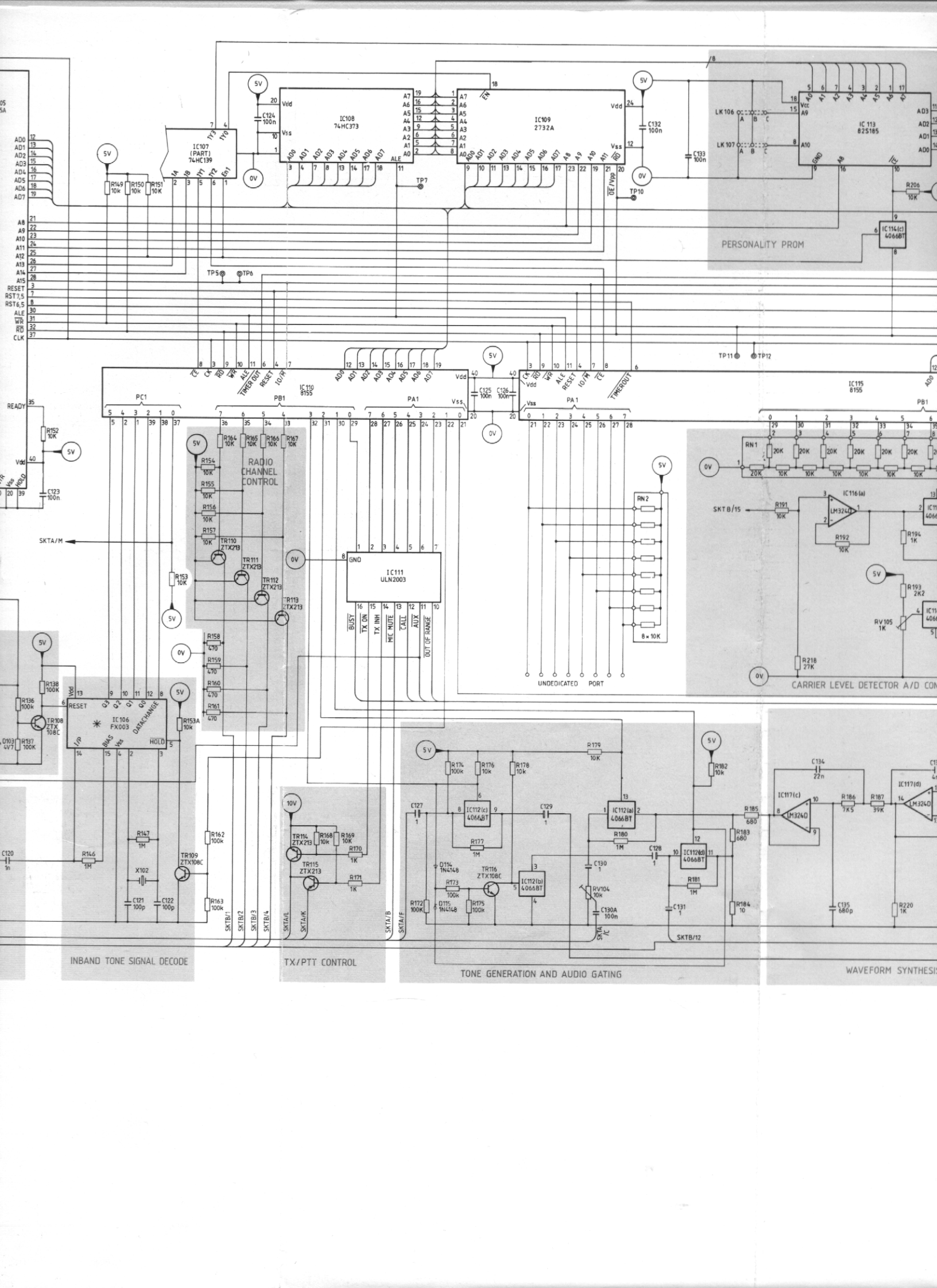


FIG. 6.3 CONTROL BOARD AND FRONT PANEL OVERALL CIRCUIT DIAGRAM


REGULATOR
PERSONALITY PROM
IC109 2732A
IC 113 82S185
IC115 8155
IC119 HEF4017BT
LM3240
4066BT
UNDEDICATED PORT
CARRIER LEVEL DETECTOR A/D CONVERTER AND COMPARATOR
TONE GENERATION AND AUDIO GATING
WAVEFORM SYNTHESIS AND FILTERING
SKT B/15
SKT B/13
SKTB/12
SKTA/F
SKTA/C
TP7
TP10
TP11
TP12
TP13
TP14
TP15


FREETONE DETECTION AND TIMING
POWER RESET
RADIO CHANNEL CONTROL
INBAND TONE AMP BUFFERS
INBAND TONE SIGNAL DECODE
TX/PTT
IC105 8085A
IC107 (PART) 74HC139
IC110 8155
IC101 HEF 4521BT
IC102 HEF4017BT
IC103 OQ2254
IC106 FX003
IC104(a)
IC104(b)
IC104(c)
IC104(d)
LM3240
TR101 ZTX108C
TR102 ZTX108C
TR103 ZTX108C
TR104 ZTX108C
TR105 BF245B
TR106 ZTX108C
TR107 ZTX108C
TR108 ZTX 108C
TR109 ZTX108C
TR110 ZTX213
TR111 ZTX213
TR112 ZTX213
TR113 ZTX213
TR114 ZTX213
LK101
LK102
LK103
LK104
LK105
SKT A
SKT B
SKTB/14
SKTA/M
SKTA/D
SKTA/E
RESET IN
RST7,5
RST6,5
IC110 PIN 37
R209
R191
0V
5V
10V
13,2V

TP223/1


PERSONALITY PROM
RADIO CHANNEL CONTROL
UNDEDICATED PORT
CARRIER LEVEL DETECTOR A/D CON
INBAND TONE SIGNAL DECODE
TX/PTT CONTROL
TONE GENERATION AND AUDIO GATING
WAVEFORM SYNTHESIS
IC108 74HC373
IC109 2732A
IC107 (PART) 74HC139
IC110 8155
IC115 8155
IC111 ULN2003
IC106 FX003 DATACHANGE
IC 113 82S185
IC116(a) LM3240
IC117(c) LM3240
IC117(d) LM3240
IC112(a) 4066BT
IC112(b) 4066BT
IC112(c) 4066BT
IC112(d) 4066BT
IC114(c) 4066BT
8×10K
SKTA/M
SKTB/15
SKTB/12
SKTB/1
SKTB/2
SKTB/3
SKTB/4
SKTA/L
SKTA/K
SKTA/B
SKTA/F
SKTA/C