Technical Manual

MA. 4231
Automatic Morse Receiver

RACAL
The Electronics Group

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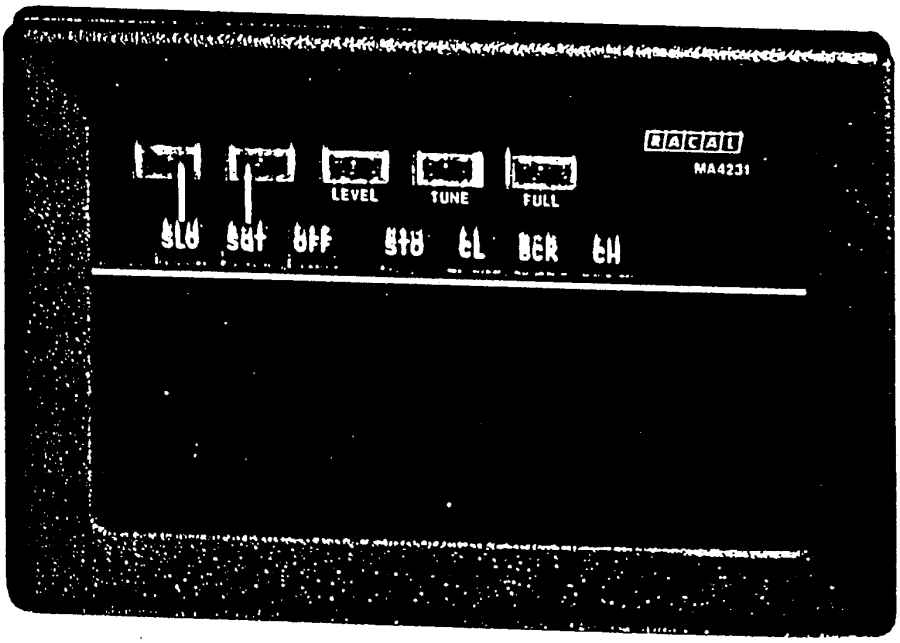

RACAL
WOH 8337

Automatic Morse Receiver

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CHAPTER 1

GENERAL DESCRIPTION

1. INTRODUCTION

1.1 The MA.4231 Automatic Morse Receiver is a small microprocessor based unit, designed to decode manual or machine generated International Morse code, in the overall speed range: 10 to 160 words per minute. The overall speed range is divided into two selectable speed ranges as follows:

(1) LO (low speed) mode: 10 to 30 words per minute.

(2) SQUIRT (fast speed) mode, 30 to 160 words per minute.

1.2 The unit provides a serial bit stream output suitable for driving an external printer, it also features a single character alpha-numeric display with associated electronics to allow decoded messages to be read character by character from its store.

1.3 Extensive measures have been taken to prevent unwanted noise/interference components appearing in the decoded output. Measures taken include the provision of:

(1) An 8 pole filter network.

(2) Noise control of a.g.c.

(3) A decoding system that discriminates against bad morse, F.S.K. interference, noise, etc.

1.4 The unit is powered by a rechargeable nickle cadmium battery supply that is capable of sustaining 10 days of message store, or 10 hours continuous operation of the unit.

2. SYSTEM CONNECTION

2.1 The MA.4231 Automatic Morse Receiver is required to be connected between a radio, or other receiving device and either a 5 unit (ITA 2) or 8 unit (ITA5) teleprinter, interfaced at the necessary logic levels.

2.2 Alternative system configurations consisting of the MA.4231, MA.4230 and MA.4233 units connected to either a Racal transceiver, or to any other conventional transceiver are shown diagrammatically in figures 1.1.1. and 1.1.2. It should be noted that it will probably be necessary to incorporate the MA.4232 Battery Charging Unit in configurations where the transceiver is of other than Racal origin.

R4

3. BASIC OPERATION

3.1 Control buttons are provided on the front panel of the unit, for selection of either Slow (SLO) or Fast (SQT) speeds of operation. The OFF button when operated removes power from the unit, but the message store remains energised. Four function buttons are provided for:

(1) Character display (CH).

(2) Clear memory (CLR).

(3) Store (STO).

(4) Character recall (BCK)

3.2 An integral dot matrix display also on the front panel allows messages to be read character by character when a printer is not available.

3.3 The front panel of the unit is also fitted with five l.e.d. indicators which show the status of the unit as follows:

(1) SLO - Lit when slow speed is selected.

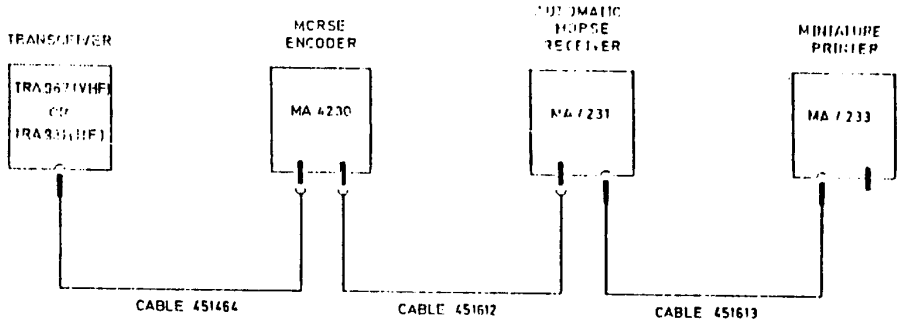
(2) SQT - Lit when fast speed is selected.

(3) FULL - Lit when store is full.

(4) LEVEL - When lit, indicates that signal is present at the correct level.

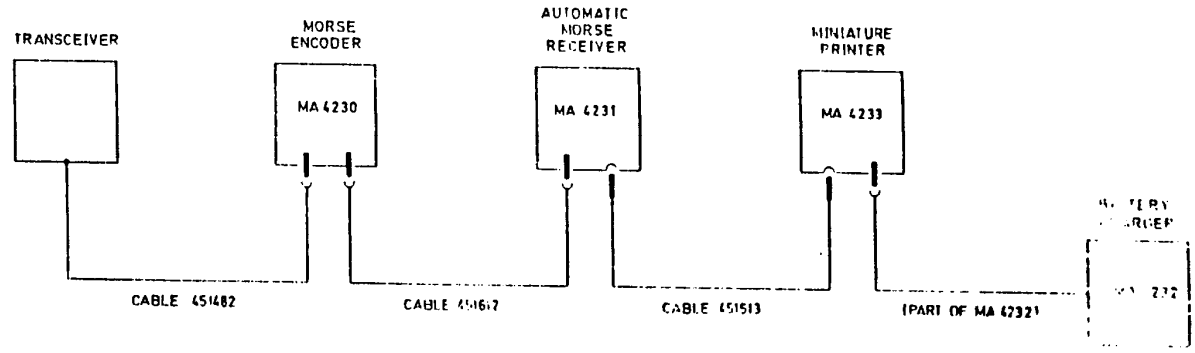
(5) TUNE - When lit, indicates that a mark is being received. The indicator reaches full brightness at nominal input tone frequency.

3.4 When the battery voltage is low, and the unit is switched on, the mode indicators ("SLO" or "SQT") will flash. If the battery voltage is very low the unit automatically turns off.



System Using Racal Transceiver

Fig. 1.1.1



System Using Transceiver of Non-Racal Manufacture

Fig. 1.1.2

SECTION 2

TECHNICAL SPECIFICATION

1. ENVIRONMENTAL SPECIFICATION

Operating temperature range:	-10°C to +55°C
Storage temperature range:	-40°C to +70°C
Charging temperature range:	0°C to +55°C
Sealing:	Robust case fully sealed.

2. MECHANICAL SPECIFICATION

Length:	170mm
Width:	114mm
Height:	58mm
Weight:	1.3Kg

3. ELECTRICAL SPECIFICATION

Signal Input (Keyed Tone)

Frequency:	1000 ± 75Hz.
Level:	50mV to 2V from 600 ohms or less. (A second input is provided for local copy of the transmitted message when using the associated MA.4230 Automatic Morse Sender).

For Essentially Error Free Reception

Minimum Signal + noise/noise of signal:	5dB typically at 15WPM measured with an input noise bandwidth 300-2700Hz.
Speed Range:	Any speed between 10 - 160WPM.

Buffer Store:	912 character non-volatile electronic memory.
Data Output:	ITA No.5 (ASC11) or ITA No.2 (BAUDOT) at 50-1200 baud. Normally set to ITA No.5 300 baud.
Power Supply:	Integral rechargeable nickle cadmium battery.
Battery Charging:	The battery may be charged from any 50mA d.c. source in the range 12-30V. With Racal and other radios, the battery receives charge whilst being operated from the radio. For charging from 120/240V a.c. mains, the MA.4232 may be used.
Battery Endurance:	Greater than 10 hours of typical operation at 25°C or 10 days message storage.

Functions

SLO:	Allows incoming morse messages in the speed range 10-30 WPM to be received and decoded.
SQT:	Conditions the unit to receive and decode morse in the speed range 30-160WPM.
	NOTE: In both SLO and SQT the received message is output to a printer if connected.
Character(CH):	For use when a printer is not available. Operating the key enables the first character of the stored message to be displayed. Releasing the key causes the display to be extinguished. Operating the key again enables the second character to be displayed, and so on.
Clear (CLR):	Erases contents of memory when operated in conjunction with (STO).
Store (STO):	Provides protection against accidental erasure of store which will occur only when this key is operated simultaneously with the CLR Key.
Back (BCK):	Used in conjunction with (CH) this key causes the previous character of the message to be displayed each time (CH) is depressed. It therefore provides a means of checking or repeating part of a message.

K9

LED Indicators

SLO:	Lit when 'SLO' mode is selected, flashes when battery needs recharging.
SQT:	Lit when 'SQT' mode is selected, flashes when battery needs recharging.
FULL:	Lit when store is full and indicates no further input data can be processed.
LEVEL:	Lit when signal is present and indicates that the signal level from the radio is sufficient.
TUNE:	Indicates when a mark is being received with full brightness at nominal input tone frequency. This facility is provided to enable the accurate setting of a continuously tuned radio.
Display:	Single character alpha numeric 7 x 5 dot matrix.

Connectors

5 pin:	For connection to associated radio (via MA.4230 if used) and charging.
5 pin:	For connection of printer.

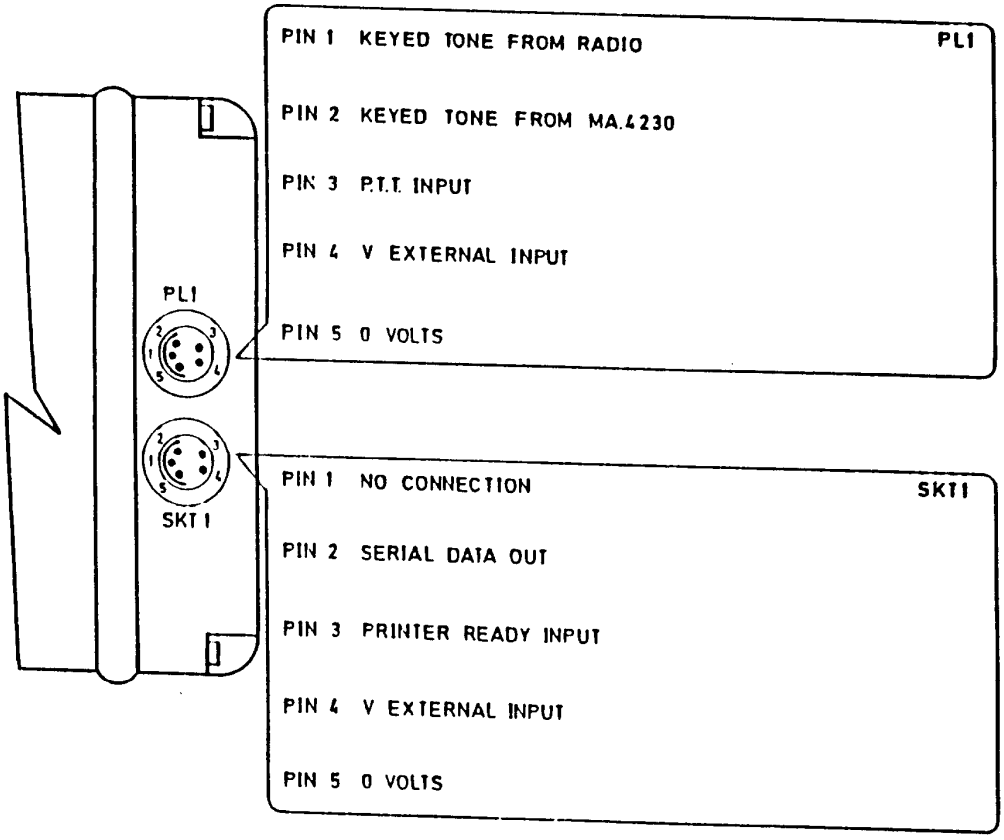


Fig. 3.2.1 MA.4231 Interconnections

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CHAPTER 2

INTERCONNECTIONS

1. INTRODUCTION

1.1 Figure 3.2.1 shows the interconnection details to plug 1 and socket 1.

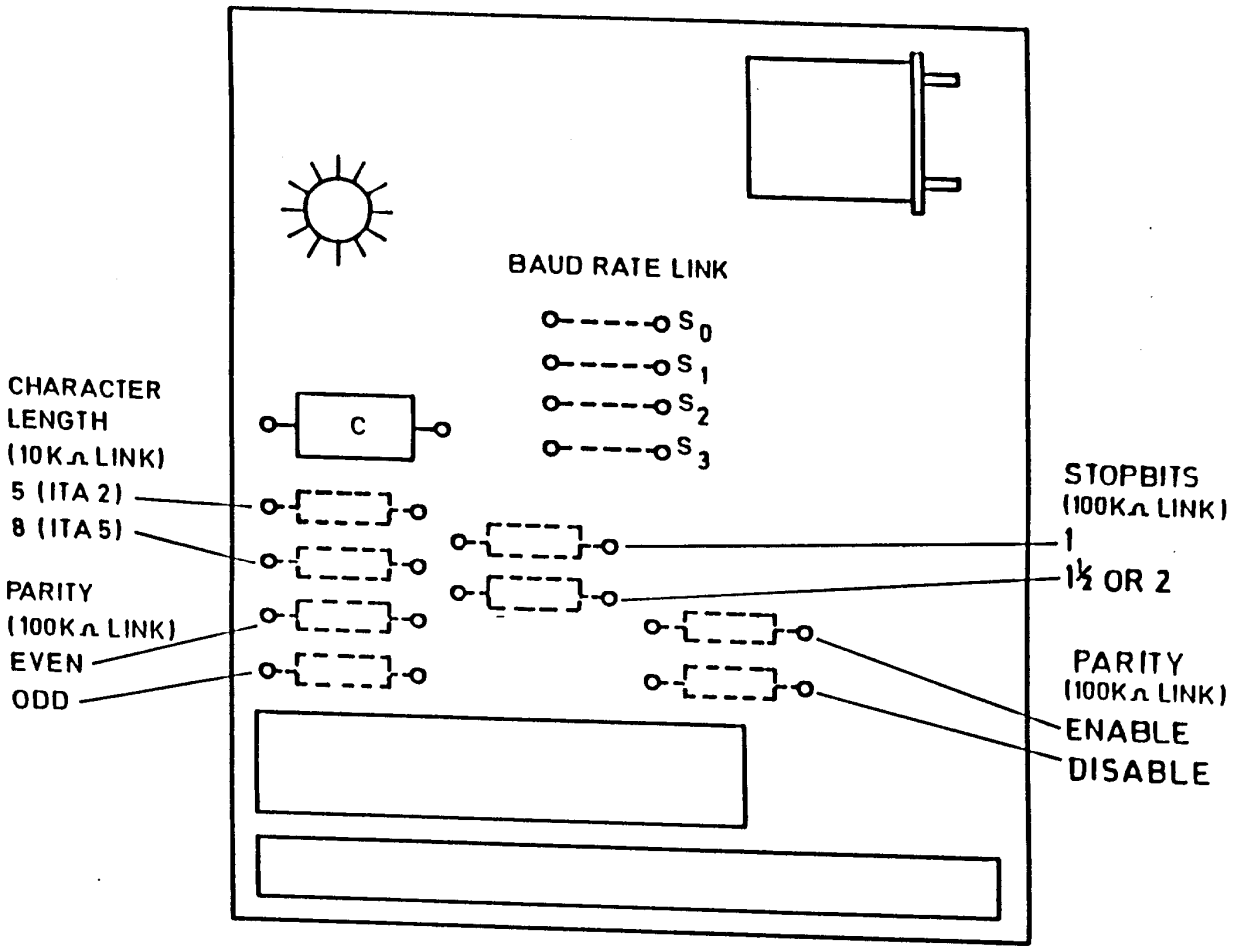
1.2 Plug 1 carries five pins and allows connection of the unit to either a transceiver, an MA.4230 Morse Encoder Unit, or an MA.4232 Charging Unit.

1.3 Socket 1 also carries five pins and allows connection of the unit to an MA.4233 Printer Unit, or via an interface unit to any other type of printer.

2. INTERFACE BOARD - LINK OPTIONS

2.1 The MA.4231 is supplied fitted with a label (see figure 3.2.2) which indicates the link options available with respect to:-

(1) Baud rate
(2) Character length
(3) Parity - even/odd
(4) Parity - enable/disable
(5) Stop bits - 1/1.5 or 2



BAUD RATE LINKS

BAUD	S_0	S_1	S_2	S_3
50	●		●	●
75			●	●
110				
134·5	●	●		●
150	●			
200		●		●
300		●		
600	●			●
1200			●	

Fig. 3.2.2 Interface Board Link Options

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CHAPTER 3

INTERFACE

1. POWER REQUIREMENTS

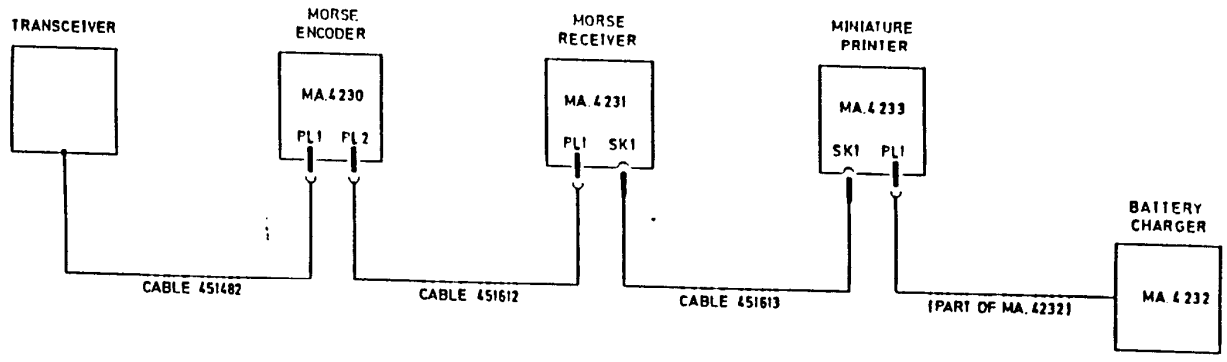
1.1 The unit is powered by an internal re-chargeable battery which provides approximately 10 hours use without charging. When the unit forms part of a system employing a Racal Transceiver, the battery is automatically recharged during normal operation. However in circumstances where the Transceiver is of other than Racal origin, it will be necessary to recharge the internal battery using the MA.4232 Battery Charging Unit.

2. RECHARGING THE INTERNAL BATTERY

2.1 Depending upon the configuration of the sytem in which the MA.4231 is employed, connection to the MA.4232 Battery Charging Unit may be achieved, using one of the following three methods:-

2.2 METHOD 1

When it is required to connect the MA.4232 Battery Charger to a system configuration consisting of a Transceiver of other than Racal design, a Morse Encoder and a Miniature Printer, then the lead from the battery charger should be connected to PL1 on the MA.4233 Miniature Printer Unit.



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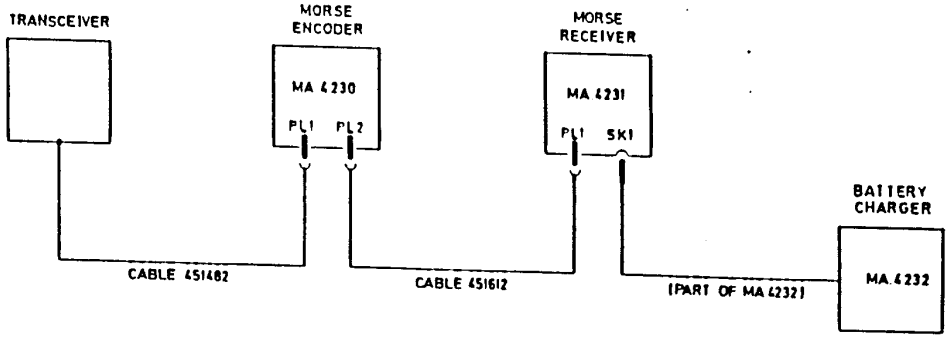
Battery Charger Connection Method 1

Fig. 3.3.1

2.3 METHOD 2

In cases where the system configuration is as alternative 1 but without a Miniature Printer Unit, then the lead from the Battery Charger should be terminated with a five pin plug (Racal Part No.932084) and connected to SKT.1 on the MA.4231 Morse Receiver Unit.



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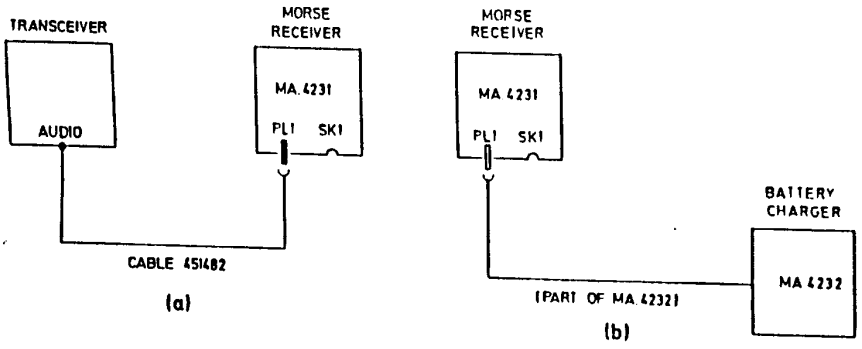
Battery Charger Connection Method 2 Fig. 3.3.2

2.4 METHOD 3

2.4.1 The MA.4231 Morse Receiver internal batteries may be recharged directly by a transceiver of Racal manufacture (see fig.3.3.3.(a)).

2.4.2 When it is required to connect the MA.4231 Morse Receiver Unit to the MA.4232 Battery Charger in isolation, then the lead from the Battery Charger should be connected to PL1 on the MA.4231 Morse Receiver Unit (see fig.3.3.3.(b)).



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Battery Charger Connection Method 3 Fig. 3.3.3

2.5 BATTERY CHARGING LEAD TERMINATION

When it is required to terminate the lead from the Battery Charging Unit with a five pin plug, the following wiring code should be adopted:-

2.5.1 WIRING CODE FOR FIVE PIN PLUG (RACAL PART NO. 932084)

SLEEVE COLOUR	PIN	FUNCTION
BROWN	4	+Ve Volts
BLUE	5	-Ve Volts

NOTE: Pins 1, 2 and 3 are not used.

3. SYSTEM CONNECTION

3.1 Although the MA.4231 Morse Receiver Unit has been primarily designed to fit into a system consisting of a Racal Transceiver type TRA.967 (VHF) or TRA 931 (HF), an MA.4230 Morse Encoder and an MA.4233 Miniature Printer as shown in figure 3.3.4, allowances have been made to provide for compatibility with systems employing Transceivers of other than Racal manufacturer as shown in figure 3.3.5. Installation of the MA.4231 within either of these sytems should be incorporated in accordance with the appropriate instructions given below.

3.1.1 INSTALLATION IN SYSTEM INCORPORATING RACAL TRANSCEIVER

For installation of the MA.4231 within a system incorporating a Racal Transceiver, refer to figure 3.3.4 and proceed as follows:-

(1) Connect cable (Racal Part No. 451464) between the AUDIO socket on the Transceiver and PL1 on the MA.4230 Morse Encoder Unit.

(2) Connect cable (Racal Part No. 451612) between PL2 on the MA.4230 Morse Encoder and PL1 on the MA.4231 Morse Receiver.

(3) Connect cable (Racal Part No. 451613) between SK1 on the MA.4231 Morse Receiver and SK1 on the MA.4233 Miniature Printer.

3.1.2 INSTALLATION IN SYSTEM EMPLOYING TRANSCEIVER OF NON RACAL MANUFACTURE

For installation of the MA.4231 within a system incorporating a Transceiver of other than Racal manufacture, refer to figure 3.3.5 and proceed as follows:-

(1) Terminate cable (Racal Part No. 451482) with the appropriate plug or socket and connect it between PL1 on the MA.4230 Morse Encoder and the Audio socket/plug on the transceiver.

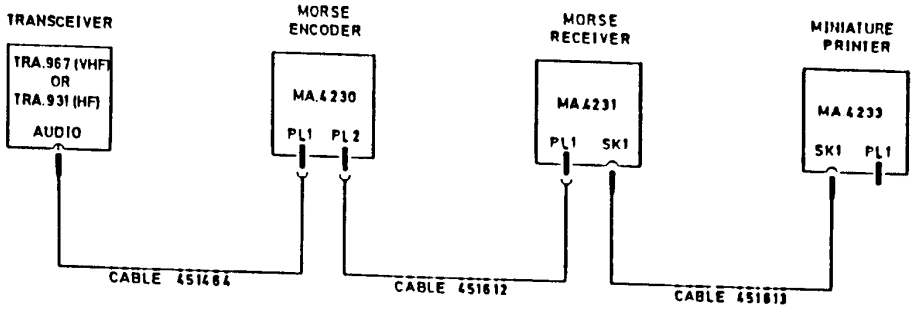
3.1.2 (2) Connect cable (Racal Part No. 451612) between PL2 on the MA.4230 Morse Encoder and PL1 on the MA.4231 Morse Receiver.

(3) Connect cable (Racal Part No. 451613) between SK1 on the MA.4231 Morse Receiver and SK1 on the MA.4233 Miniature Printer.

(4) If required install the MA.4232 Battery Charger in accordance with the instructions given in paragraph 2.2.

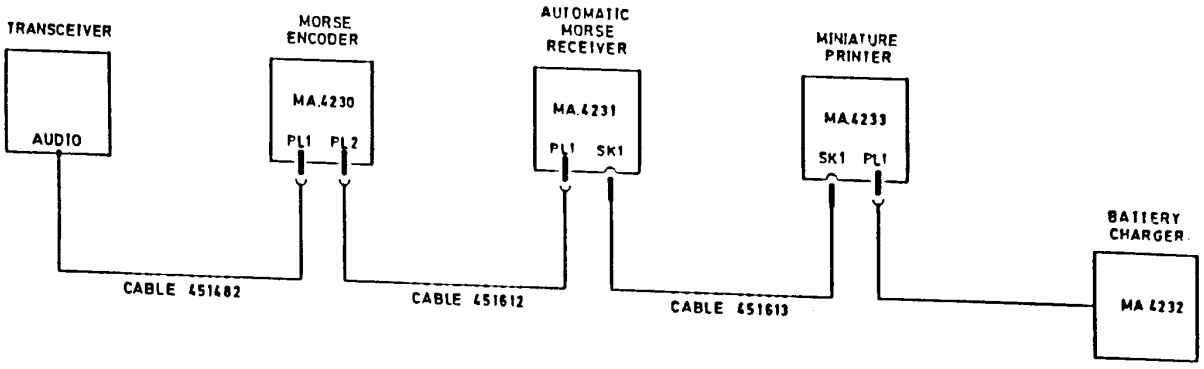
4. INTERFACE CONNECTIONS

Figures 3.3.6, 3.3.7 and 3.3.8 show the interface connections to the MA.4230, MA.4231 and MA.4233 respectively.



System Using Racal Transceiver
(Power Drawn From Transceiver)

Fig. 3.3.4



System Using Transceiver of Non-Racal Manufacture
(Power Drawn From MA.4232)

Fig. 3.3.5

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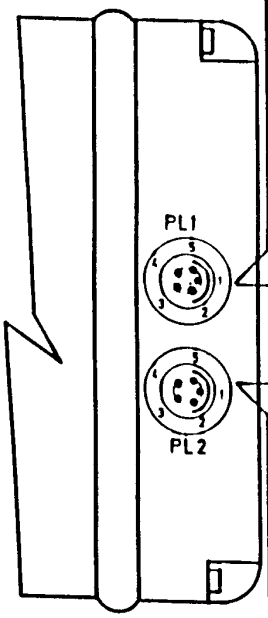

PL1

PIN 1 NOT USED BY MA.4230 BUT CONNECTED TO PIN 1 OF OTHER CONNECTOR TO PROVIDE THROUGH CONNECTION OF KEYED TONE FROM RADIO WHEN USED WITH MA.4231.

PIN 2 KEYED TONE OUT- 1000Hz ± 20Hz @ 20mV ± 3dB FROM 300

PIN 3 PTT OUTPUT - CONTACT CLOSURE TO 0V WHEN THE MA4230 IS SENDING MORSE - CONTACTS REMAIN CLOSED FOR 1 SEC. AFTER COMPLETION OF LAST CHARACTER (CONTACT RATING ½ A.D.C.)

PIN 4 V EXTERNAL INPUT:- A 12-30V D.C. 50mA INPUT WILL CHARGE THE INTERNAL BATTERIES

PIN 5 0 VOLTS.

PL2

PIN 1 NOT USED BY MA.4230 BUT CONNECTED TO PIN 1 OF OTHER CONNECTOR TO PROVIDE THROUGH CONNECTION OF KEYED TONE FROM RADIO WHEN USED WITH MA.4231.

PIN 2 KEYED TONE OUT- 1000Hz ± 20Hz @ 20mV ± 3dB FROM 300

PIN 3 PTT OUTPUT - CONTACT CLOSURE TO 0V WHEN THE MA.4230 IS SENDING MORSE-CONTACTS REMAIN CLOSED FOR 1 SEC. AFTER COMPLETION OF LAST CHARACTER (CONTACT RATING ½ A.D.C.)

PIN 4 V EXTERNAL INPUT:- A 12-30V D.C. 50mA INPUT WILL CHARGE THE INTERNAL BATTERIES

PIN 5 0 VOLTS.

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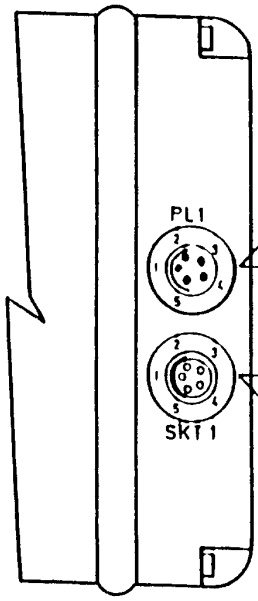
Interface Connections MA.4230

Fig.3.3.6

R1



PL1

PIN 1 KEYED TONE FROM RADIO - 50mV TO 2V FROM 600 ohms @ 1000 ± 75Hz ($\frac{\text{SIGNAL + NOISE}}{\text{NOISE}}$ 5dB @ 15wpm)

PIN 2 KEYED TONE FROM MA.4230:- 20mV ± 3dB @ 1000 ± 75Hz

PIN 3 P.T.T. INPUT:- SELECTS THE SIGNAL ON PIN 1 AS INPUT WHEN HI AND THE SIGNAL ON PIN 2 AS INPUT WHEN LO.

PIN 4 V EXTERNAL INPUT:- A 12-30V D.C. 50mA INPUT WILL CHARGE THE INTERNAL BATTERIES

PIN 5 0 VOLTS.

SKT 1

PIN 1 NO CONNECTION.

PIN 2 SERIAL DATA OUT:- ITA 2 OR ITA 5 SERIAL ASYNCHRONOUS DATA AT 6V CMOS LOGIC LEVELS @ 50-1200 BAUD. NORMALLY ITA 5 @ 300 BAUD.

PIN 3 PRINTER READY INPUT:- A LOGIC 'LO' ENABLES DATA OUTPUT TO REMOTE PRINTER

PIN 4 V EXTERNAL INPUT:- A 12-30V D.C. 50mA INPUT WILL CHARGE THE INTERNAL BATTERY.

PIN 5 0 VOLTS.

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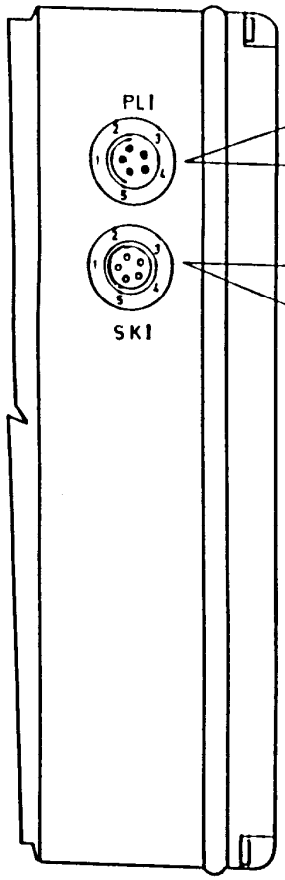
Interface Connections MA.4231

Fig.3.3.7



PIN 1	NO CONNECTION
PIN 2	NO CONNECTION
PIN 3	NO CONNECTION
PIN 4	V EXTERNAL A 12-30V DC 90mA INPUT WILL CHARGE THE INTERNAL BATTERIES
PIN 5	0 VOLTS

PIN 1	NO CONNECTION
PIN 2	SEND DATA IN - ITA 2 OR ITA 5 DATA @ 50 - 600 BAUD IN ASYNCHRONOUS CHARACTER FORMAT - i.e. 7½ ELEMENTS/CHARACTER FOR ITA 2 11 ELEMENTS/CHARACTER FOR ITA 5 @ 110 BAUD AND 10 ELEMENTS/CHARACTER AT OTHER SPEEDS
PIN 3	PRINTER READY OUTPUT - A LOW LEVEL ON THIS LINE INDICATES THAT THE PRINTER IS SWITCHED ON AND READY TO ACCEPT DATA
PIN 4	V EXTERNAL - A 12-30V D.C. 90mA INPUT WILL CHARGE THE INTERNAL BATTERIES
PIN 5	0 VOLTS

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Interface Connections MA.4233 Fig.3.3.8

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CHAPTER 1

CONTROLS AND INDICATORS

1. OPERATING CONTROLS AND INDICATORS

All operator controls and indicators are located on the front panel of the unit as illustrated in figure 4.1.1.

2. Controls

The functions of the controls are listed below.

CONTROL	DRAWING REF (Fig.4.1.1)	FUNCTION
SLO	(1)	Selects ON in the SLOW speed Mode and allows messages in the speed range 10-30 words per minute to be received and decoded.
SQT	(3)	Selects ON in the SQUIRT Mode and allows messages in the speed range 30-160 words per minute to be received and decoded.
CH	(12)	Operation of this key enables the first character of the stored message to be displayed. Releasing the key causes the display to be extinguished. Operation of the key again, enables the second character to be displayed, and so on.
OFF	(5)	Switches the Unit OFF but data is retained in the store.
STO	(7)	Provides protection against accidental erasure of store which will occur only when this key is operated simulataneously with the CLR key.

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CONTROL	DRAWING REF	FUNCTION
CL	(9)	Erases the contents of the memory when operated in conjunction with the STO key.
BCK	(10)	When used in conjunction with the CH key this key causes the previous character of the message to be displayed each time CH is depressed. It therefore provides a means of checking or repeating part of a message.

3. INDICATORS

The functions of the indicators are listed below.

INDICATOR	DRAWING REF (Fig.4.1.1)	FUNCTION
SLO	(2)	Lights when SLO mode is selected flashes when battery needs recharging.
SQT	(4)	Lights when SQT mode is selected, flashes when battery needs recharging.
LEVEL	(6)	Lights when signal is present and indicates that the signal level from the radio is adequate.
TUNE	(8)	Indicates when a Mark is being received, achieves full brightness at the nominal input tone frequency. This facility enables the accurate setting of a continuously tuned radio.
FULL	(11)	Lights when store is full and indicates that no further input data can be processed.
DISPLAY	(13)	A single character alpha numeric 7 x 5 dot matrix display.

CHAPTER 2

OPERATING PROCEDURE

1. INTRODUCTION

1.1 The MA.4231 Automatic Morse Receiver provides for automatic reception of the morse code. The device will accept both machine generated morse code up to 160 words per minute and hand generated morse code. All operator controls are located on the front panel of the Unit as shown in figure 4.1.1.

2. RECEPTION

2.1 Check that the MA.4231 unit is correctly installed in accordance with one of the alternative system configurations given in Section 3 and that the other units in the system are functioning correctly.

2.2 SQUIRT MODE

2.2.1 Depress the SQT button, annotated (3) in figure 4.1.1. Check that the associated indicator, annotated (4) in figure 4.1.1., lights and does not flash intermittently.

2.2.2 If a printer is connected to the unit, incoming morse will be automatically decoded and printed.

2.2.3 When the message is complete depress the OFF button, annotated (5) in figure 4.1.1 and the message will remain in store.

2.3 SLOW MODE

2.3.1 Depress the SLO button, annotated (1) in figure 4.1.1. Check that the associated indicator, annotated (2) in figure 4.1.1, lights and does not flash intermittently.

2.3.2 If a printer is connected to the unit, incoming morse will be automatically decoded and printed.

2.3.3 When the message is complete depress the OFF button, annotated (5) in figure 4.1.1 and the message will remain in store.

NOTE: If either the SLO or the SQT lights flash, or fail to light when the appropriate buttons are depressed, the battery is discharged.

3. MESSAGE DISPLAY WITHOUT A PRINTER

3.1 With the unit operating in either the SLO mode or the SQT mode, the incoming message may be displayed character by character in the display window, annotated (13) in figure 4.1.1, as follows:-

(1) Depress the CH button, annotated (12) in figure 4.1.1 and keep it depressed to display the first character.

(2) Release the CH button and then depress it again to display the next character.

3.2 When it is required to display a message without a printer and the unit has been switched to OFF, following reception of a previous message, then either the SLO button, annotated (1) in figure 4.1.1, or the SQT button, annotated (2) in figure 4.1.1, should be depressed before implementation of the action detailed in para. 3.1.

4. REPEATING A MESSAGE

4.1 A "Back" facility is provided to enable the operator to manually recall the individual characters of a previously stored message. This facility should be used as follows:-

(1) Depress the BCK button, annotated (10) in figure 4.1.1.

(2) Whilst keeping the BCK button held down, depress and hold down the CH button, annotated (12) in figure 4.1.1, to display the last character stored in the memory.

(3) Release the CH button and then depress and hold it down again to display the next character back. Repeat this action until the required message or part thereof has been displayed.

(4) On completion of the recalled message release the BCK button and if a printer is connected to the unit, the recalled message will be printed forwards again.

5. CLEARANCE OF ALL MESSAGES FROM STORE

5.1 The 912 character store may be cleared of all messages by adopting the following procedure:-

(1) If the unit is switched to OFF depress the SLO button, annotated (1) in figure 4.1.1.

(2) Depress the STO button, annotated (7) in figure 4.1.1 and the CL button, annotated (9) in figure 4.1.1. simultaneously.

6. BATTERY STATE

If an indication is received that the battery is either low or discharged, it may be re-charged from and the unit operated by any d.c. source between 12 and 30 volts, or from the normal mains supply via an MA.4232 Battery Charging Unit. The nominal charging current is 50mA and full charge is accomplished in fourteen hours.

NOTE: The MA.4232 Battery Charging Unit should not be used whilst the MA.4231 is receiving power from a radio.

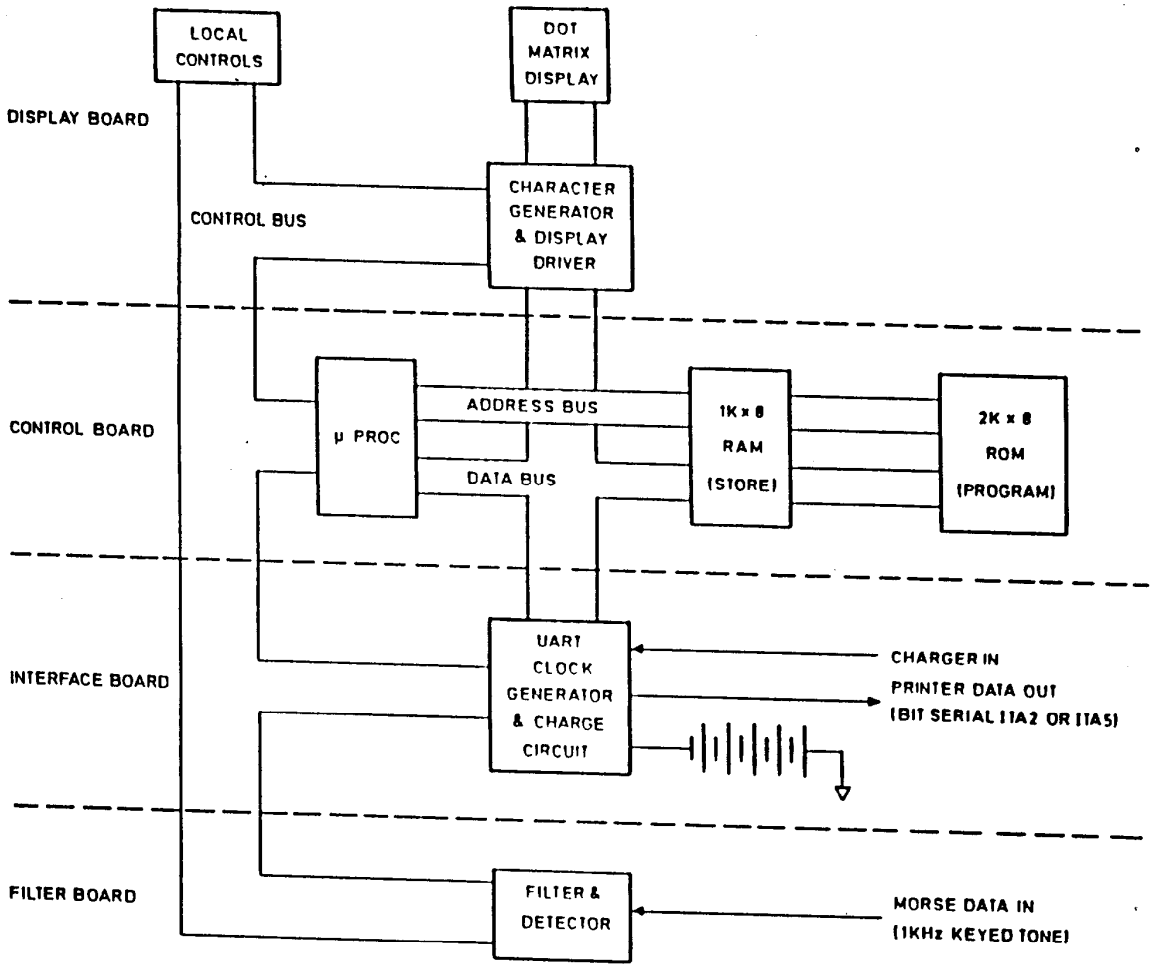


Fig. 5.1.1 MA.4231 Block Diagram

R21

CHAPTER 1

PRINCIPLES OF OPERATION

1. INTRODUCTION

1.1 The MA.4231 is a self contained microprocessor based unit that provides a means of automatically decoding either manual, or machine generated morse code. The decoded characters are stored and output, on request, on a single character display, additionally they are fed to an external printer if connected.

2. CONSTRUCTION

2.1 The unit consists of four printed circuit boards and is shown in block diagram form in Fig. 5.1.1. The basic function of each of the printed circuit boards is as follows:-

(1) Filter board: This circuit converts the low level 1 kHz keyed tone input, provided by the Radio (or other receiving device) into a logic level, that is HIGH when the tone is present and LOW when the tone is absent.

(2) Control board: This board provides overall system control, decodes the output of the filter board and provides storage for the decoded characters, until output is requested by the display board, or interface board.

(3) Display board: This board provides an interface between the local controls and indicators and the microprocessor. It also provides a single character alpha-numeric display and includes associated electronics, that allow the decoded message to be read, character by character, from store.

(4) Interface board: This board provides the system master clock, battery charging circuit and the circuitry necessary to convert the decoded characters output by the microprocessor, into a serial bit stream suitable for driving an external printer.

3. BASIC OPERATION

3.1 Overall control of the system, together with memory management and the decoding of the morse input signal, is carried out by an 8 bit microprocessor, located on the Control board.

3.2 The Filter board converts the keyed tone input signal into a logic level that is HIGH when tone is present and LOW when tone is absent.

3.3 The microprocessor measures the time for which the Filter board detector output rests HIGH and LOW, then using references derived from the data itself, converts the variable length marks and spaces into 8-bit representations of the morse characters (dots represented by ones and dashes represented by zeros). As each character becomes available, it is stored in successive locations of a one thousand character random access memory. When required, the data is taken out of the memory and converted into either 8-bit (ITA 5) or 5-bit (ITA-2) characters.

3.4 Fig. 5.1.2 shows the overall flow chart for the system in much simplified form.

4. TIME INTERVAL MEASUREMENT

4.1 The intervals between changes of state of the output of the Filter board, equate to the duration of the marks (dots, dashes) and spaces and are measured by means of a software count. Each time the Filter board morse output changes, an Interrupt is generated and applied to the microprocessor. The count accumulated since the previous interrupt is then stored in the Memory (RAM) and the counter reset. Since the MA.4231 Morse Receiver Unit is required to operate over a wide input speed range (caused by the necessity to decode both manual morse and machine generated morse) the effective clock rate applied to the software counter is automatically adjusted to prevent the dash count exceeding 7 bits.

5. INITIALISATION - ESTABLISHING REFERENCES

5.1 Since the MA.4231 is required to decode manual morse as well as machine generated morse over a wide speed range, it is not possible to rely on the morse possessing the classic 3 : 1 dash : dot ratio. The MA.4231 employs four separate references: One for dashes, one for dots, one for interelement-spaces and one for intercharacter spaces, which must be established before decoding can take place.

5.2 The purpose of the Initialisation programme is to establish these references. The programme is entered automatically at:

(1) The start of each message or,

(2) Following a long space or,

(3) following a pre-determined number of random data characters resulting from a noise burst at the input.

5.3 The programme establishes the references as follows:-

5.3.1 Each input count, as it is received and stored, is compared with other similar counts, for example, marks (dots and dashes) with marks or alternatively spaces (interelement and intercharacter) with spaces.

5.3.2 Counts that are within 25% of each other are grouped together to form what is in effect, a histogram of input count values. When four groups (two marks and two spaces) each containing more than four separate counts have been accumulated, the mean values for each of the groups are taken as the initial dot, dash, inter-element and intercharacter spaces. If more than six groups of similar counts should have been received without four groups having reached a count of four, then the mean values of the groups containing the greatest number of counts are taken as initial references.

5.3.3 These four references are then subjected to a ratio check, the limits of which are such as to reject references arising from FSK telegraph data, whilst still accepting those produced by both machine, or hand generated morse. If these references do not pass the ratio check, the stored counts and references are cleared from the store and the Initialisation routine is repeated.

6. DECODING

6.1 The references determined in the initialisation programme, described above, are used to classify each input (including those stored, whilst establishing the references) as either a dot, dash, interelement or intercharacter space. When subsequent counts are decoded they are used to update the appropriate reference. Any count value which is less than 25% of the stored dot reference is recognised as an interference pulse and its count value is added to that of the adjacent count, to provide one total count, so that the interference pulse is in effect ignored.

6.2 Each time an intercharacter space is detected, the dots and dashes decoded since the previous intercharacter space are assembled as an eight bit morse character.

7. STORAGE

7.1 When a character has been assembled, as described above, it is stored in the random access memory. The message storage area of the RAM (which is 912 bytes in capacity) is organised as a "First In First Out" memory. i.e. characters are stored in successive RAM locations to await output, when the top of store is reached, the next character is stored in the bottom location. Thus the store will always contain the last 912 characters received.

8. OUTPUT

8.1 The status of the display board and the output interface is continuously interrogated by the microprocessor. When either is ready to accept a character an output routine is entered. The output routine takes characters from RAM and uses the stored data to address a 'look up' table (stored in ROM) which contains the appropriate ITA 2 or ITA 5 code for the morse character.

8.2 This code is then supplied to either the Display Module or to the Interface Module as appropriate.

8.3 When the output is to a teleprinter, the unit supplies data isochronously for as long as the printer is ready and there is data in the RAM awaiting output.

9. INITIALISATION REQUIREMENTS

9.1 The MA.4231 decodes morse signals by comparing the length of each received morse element and space with internally stored references. Separate references for 'dot' 'dash' - 'interelement' space and 'intercharacter' space are stored to ensure successful decoding of both machine and manually generated morse over a wide speed range. These stored references must be established from the incoming morse itself before decoding can commence. To do this the MA.4231 requires up to 4 dots, 4 dashes, 4 interelement spaces and 4 intercharacter spaces on which to 'initialise' (or commence the decoding process).

9.2 Following initialisation the MA.4231 will use the established references to decode up to 32 dots and dashes that were received during, and used in, the initialisation process.

9.3 To initialise and decode without data loss, therefore, the first 32 morse elements of a transmission should contain the specified number of dots and dashes.

9.4 To discriminate between noise and valid morse signals the MA.4231 monitors the incoming morse and will terminate the decoding process if certain limits are exceeded.

These are:-

(1) More than 23 dots without a dash.

(2) More than 22 dashes without a dot.

(3) More than 22 interelement spaces without an intercharacter space.

(4) More than 6 intercharacter spaces without an interelement space.

When decoding is terminated for one of the above reasons, the MA.4231 will automatically re-enter the initialisation routine and attempt to establish new references.

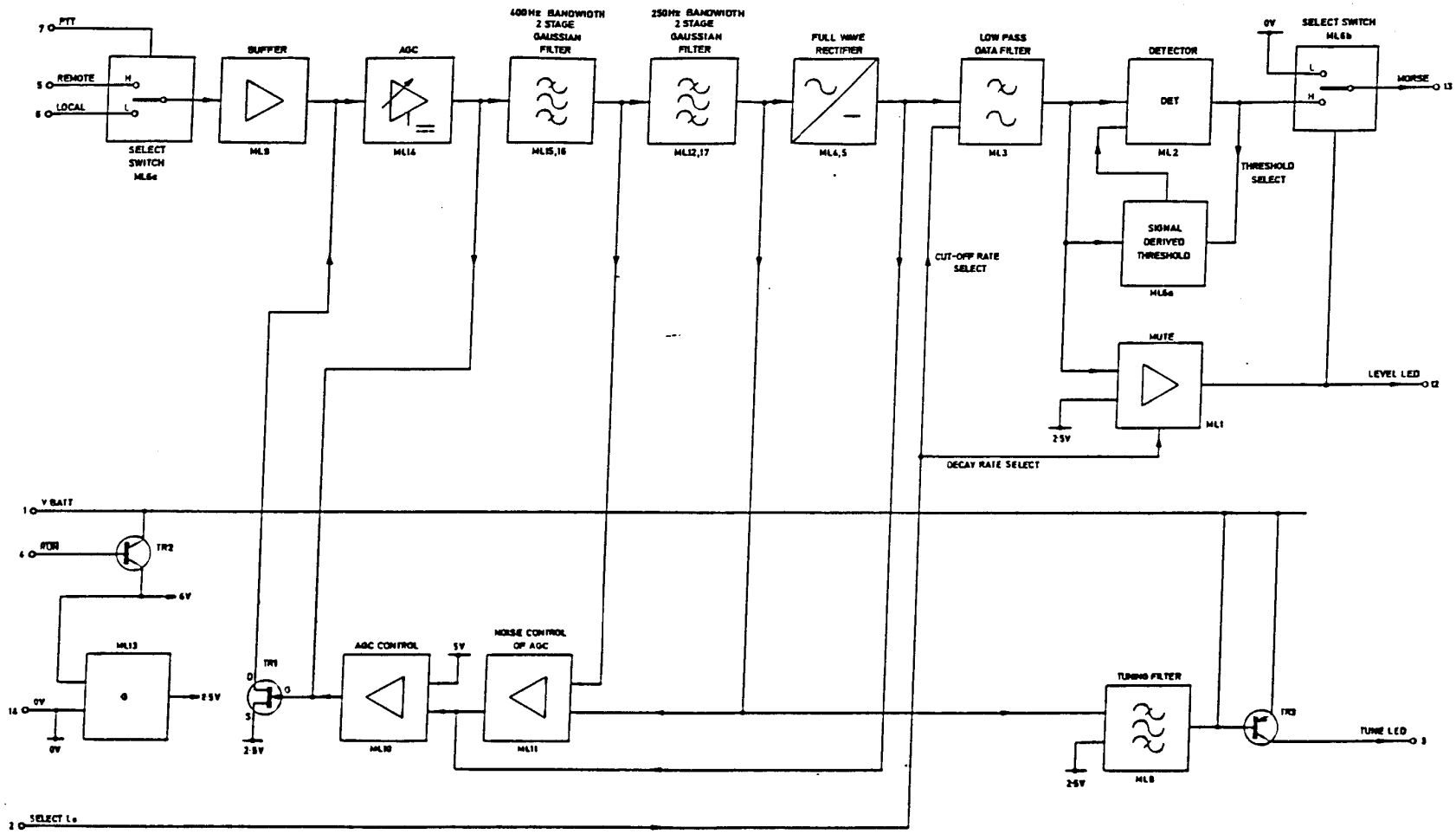
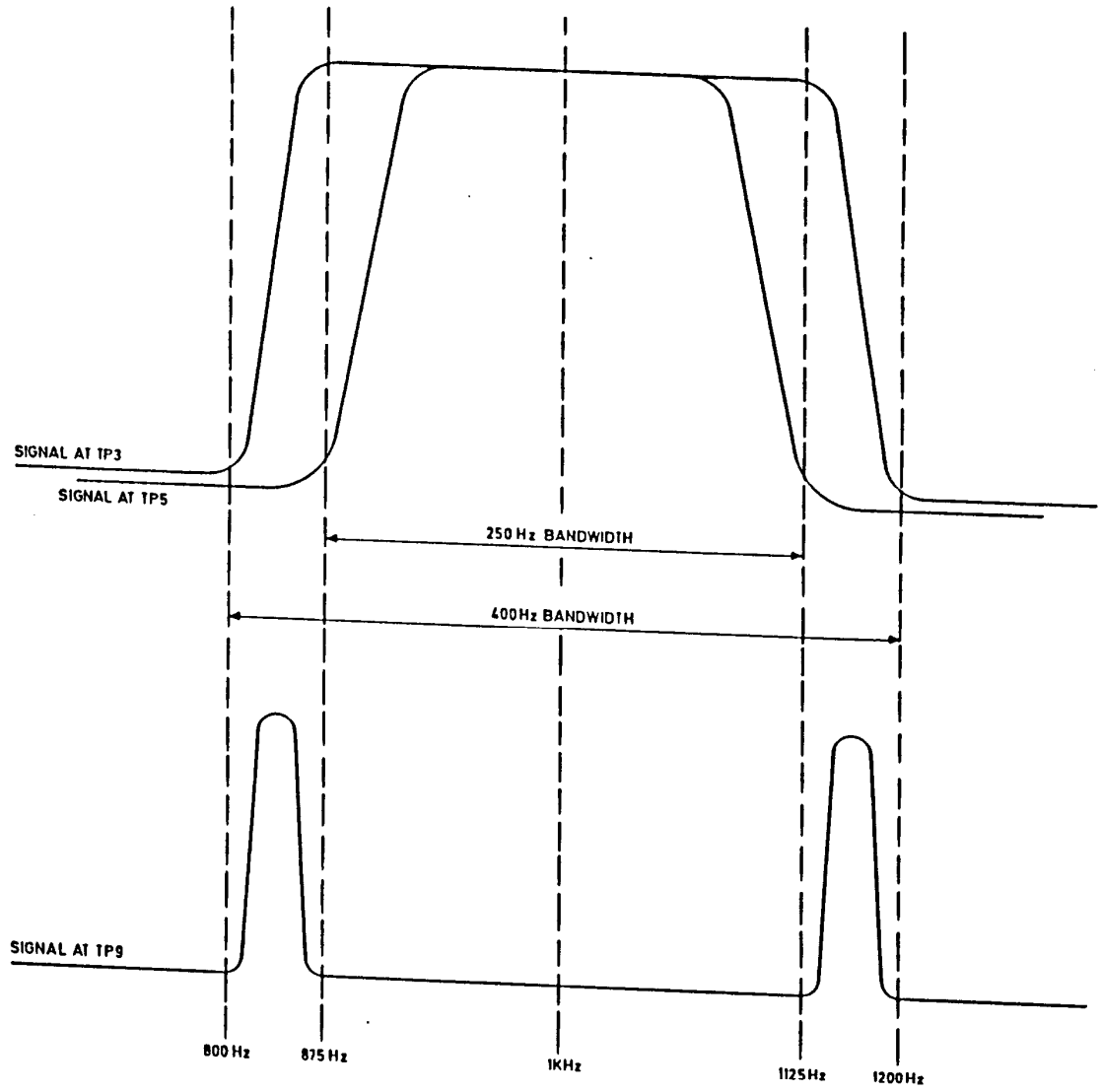


Fig. 5.2.1 Morse Receiver Filter Block Diagram



NOTE:- RESISTOR R29 IS ADJUSTED FOR MINIMUM SIGNAL AT TP9 AT 1KHz

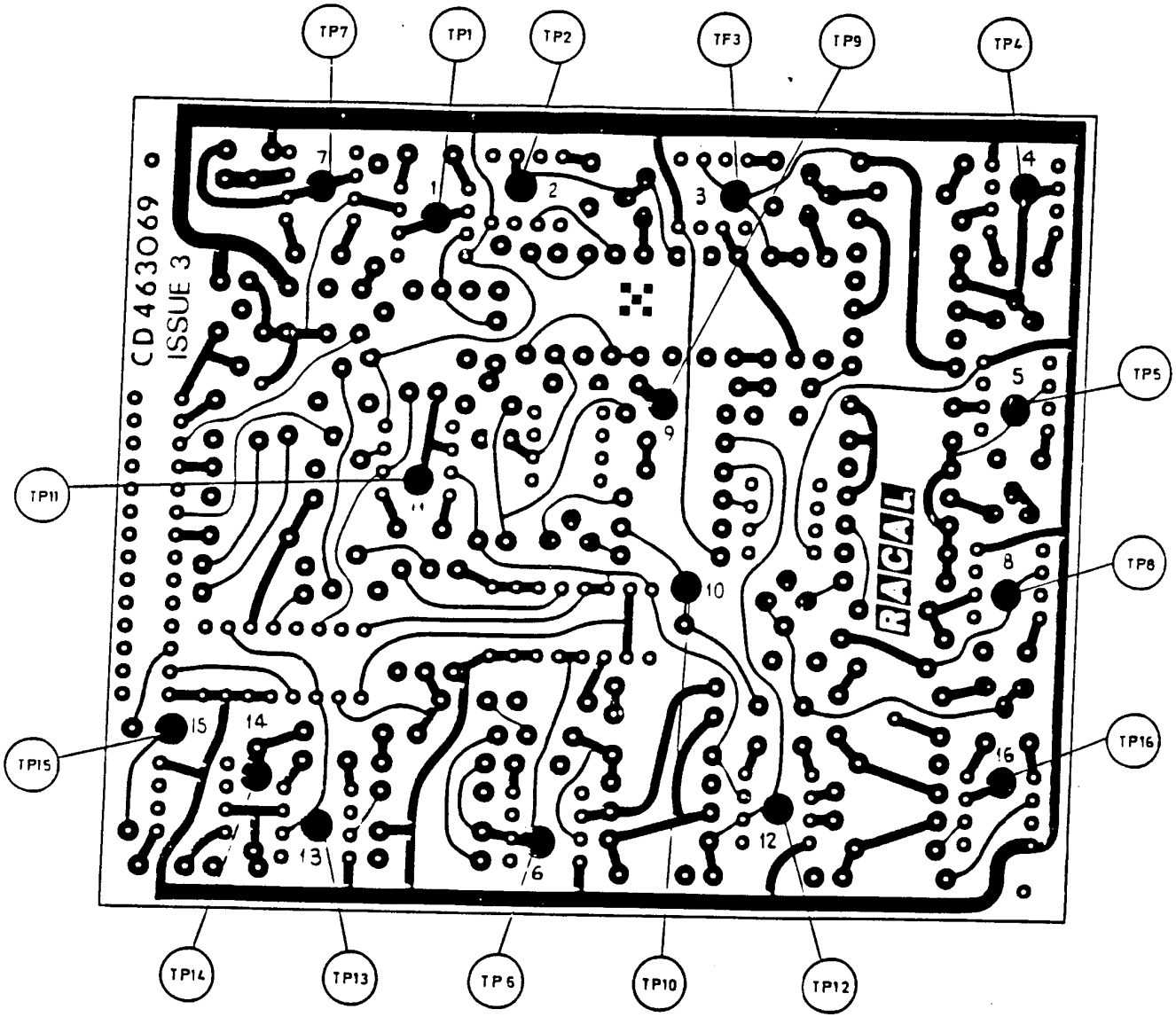
RACAL
WOH 8337

Noise Control of A.G.C

Fig.5.2.

TABLE 1 – INTERFACE

DESIGNATION	SIGNAL TYPE	FUNCTION	PIN NO.
0V	SUPPLY	0 Volt Common	14
V BATT.	SUPPLY	+5 Volt Battery Input	1
LOCAL	INPUT	Keyed tone audio input from Local MA.4230	6
P.T.T.	INPUT	Selects Local or Remote Input	7
REMOTE	INPUT	Keyed tone audio input from radio	5
$\overline{\text{RUN}}$	INPUT	Power ON/OFF Control Signal	4
SELECT LO	INPUT	Provides selection of squirt or low speed modes	2
LEVEL LED	OUTPUT	Output to level indicator	12
MORSE	OUTPUT	Detected signal output to interface board	13
TUNE LED	OUTPUT	Output to tuning indicator	3



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MA.4231 Filter Board
Test Point (Trackside)

Fig. 5.2.3

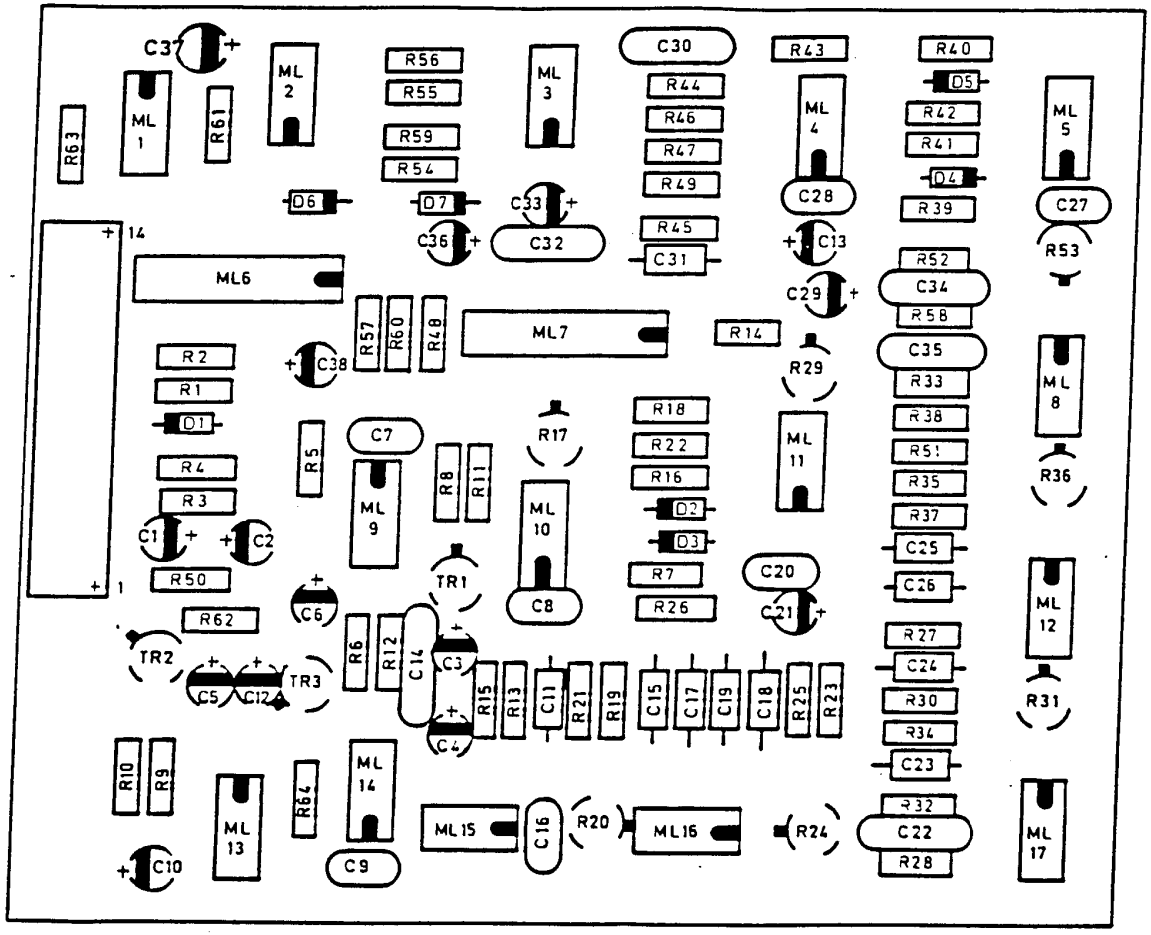
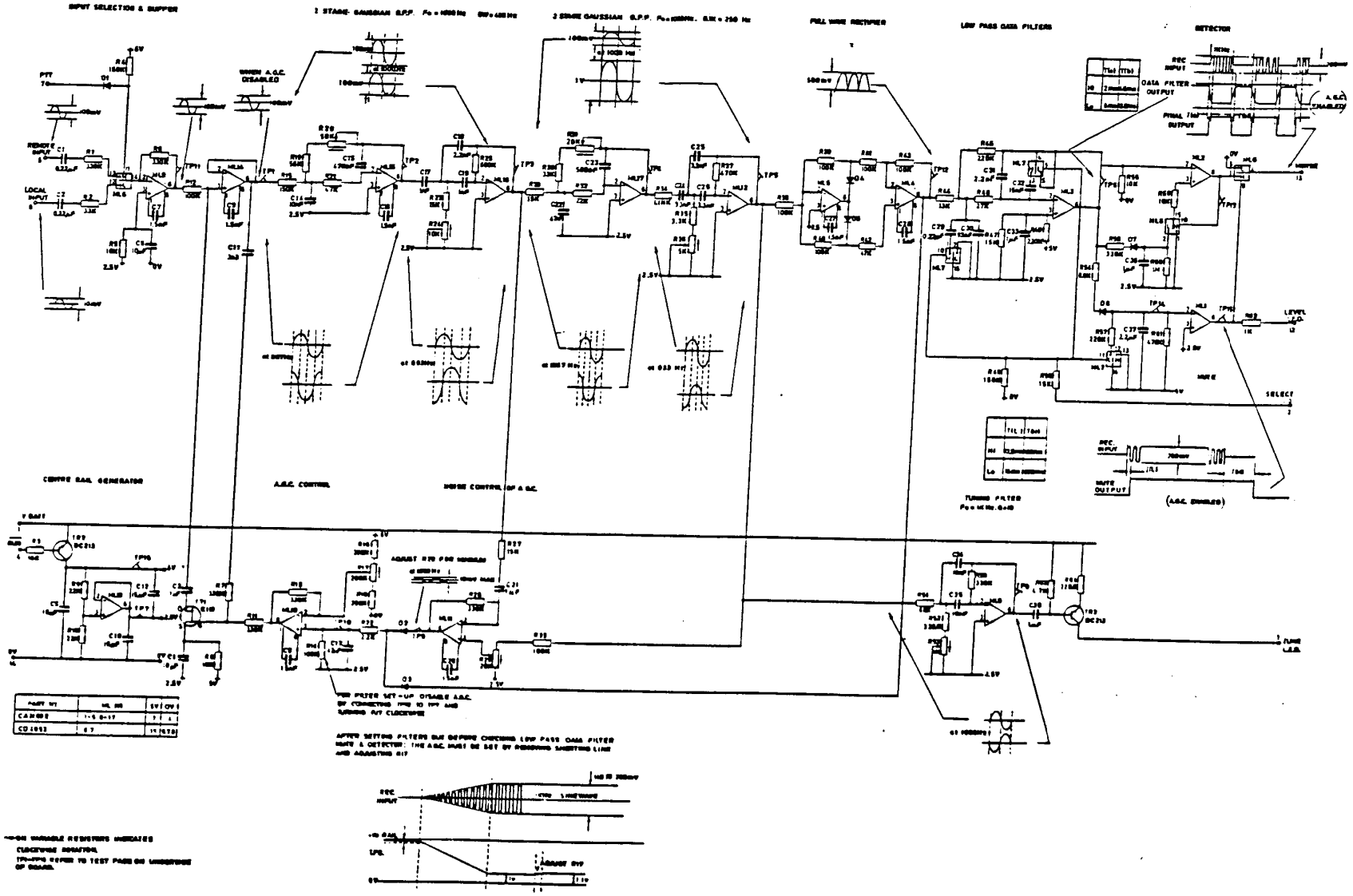


Fig. 5.2.4 MA.4231 Filter Board

R35
1



MA.4231 Filter Board

Fig5.2.5

R34

TABLE 1 – INTERFACE

DESIGNATION	SIGNAL TYPE	FUNCTION	PIN NO.
0V	SUPPLY		32
V. BATT.	SUPPLY	+5 Volt battery input	1
CLOCK	INPUT	Master clock input	2
$\overline{EF1}$	INPUT	Status flags sensed by the microprocessor	19
$\overline{EF2}$	INPUT		20
$\overline{EF3}$	INPUT		21
$\overline{EF4}$	INPUT		22
INTERRUPT	INPUT	Interrupts the main program. Running in the microprocessor	28
INTERRUPT ENABLE	INPUT	Causes the microprocessor to acknowledge interrupts	24
$\overline{REQ\ OFF}$	INPUT	Requests that the microprocessor turn off	26
RESET	INPUT	Resets the microprocessor	23
$\overline{TRE}$	INPUT	Prevents microprocessor turning off when a character is being output	25
D0	INPUT/OUTPUT	Data bus for input and output of data	14
D1	INPUT/OUTPUT		13
D2	INPUT/OUTPUT		12
D3	INPUT/OUTPUT		11
D4	INPUT/OUTPUT	Data bus for input and output of data	10
D5	INPUT/OUTPUT		9
D6	INPUT/OUTPUT		8
D7	INPUT/OUTPUT		7
LATCHED Q	OUTPUT	Latched status output	31
$\overline{MRD}$	OUTPUT	Indicates that microprocessor has sampled the data bus	30
N0	OUTPUT	Input/output transfer instruction for data bus	18
N1	OUTPUT		17
N2	OUTPUT		16
Q	OUTPUT	Status line output by microprocessor	29
RUN	OUTPUT	Indicates that program is running	27
SC0	OUTPUT	Indicates cycle being executed by microprocessor	4
SC1	OUTPUT		3
TPA	OUTPUT	Microprocessor timing signals	5
TPB	OUTPUT		6

R37

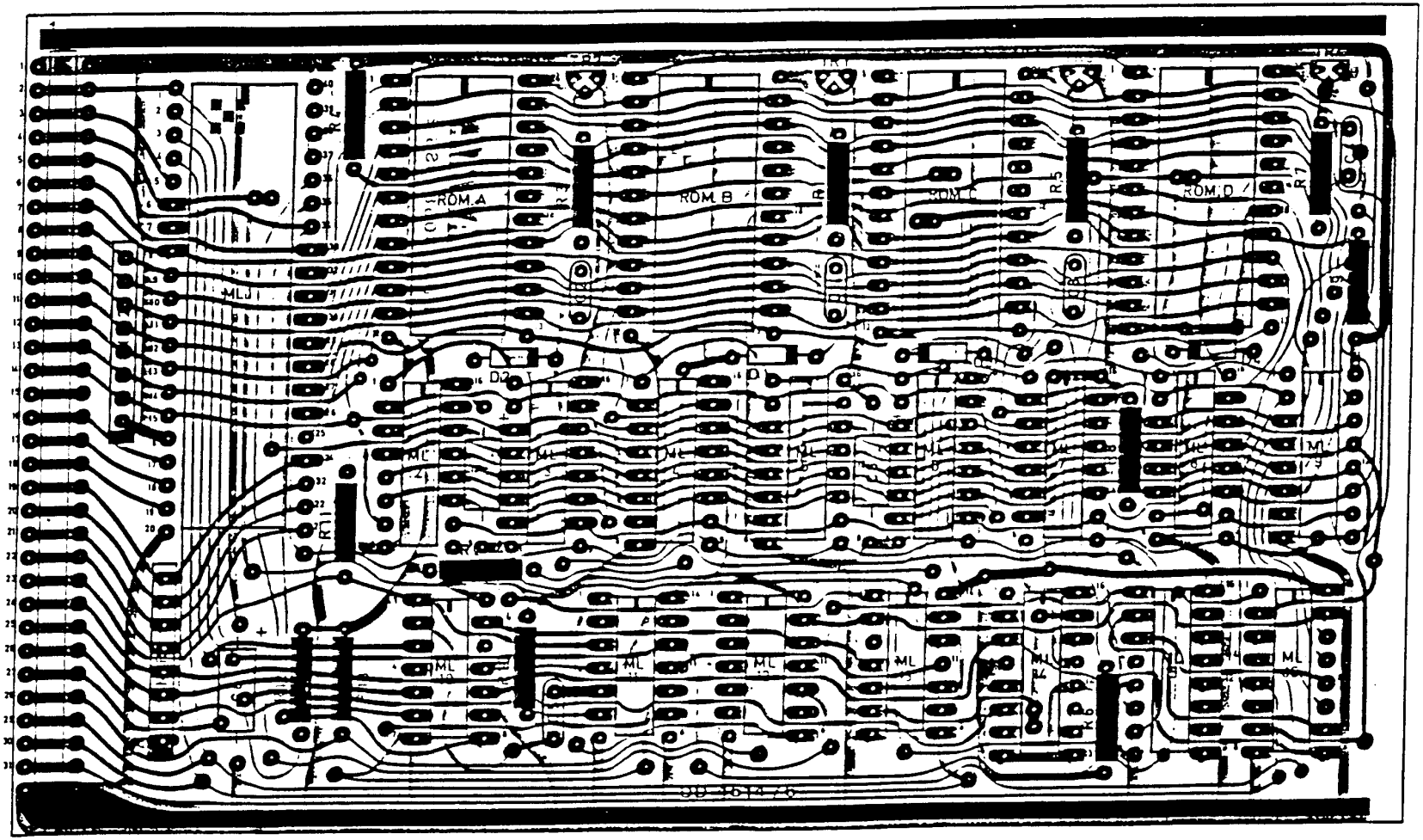


Fig. 5.3.3 MA.4231 Control Board
P.C.B. Layout

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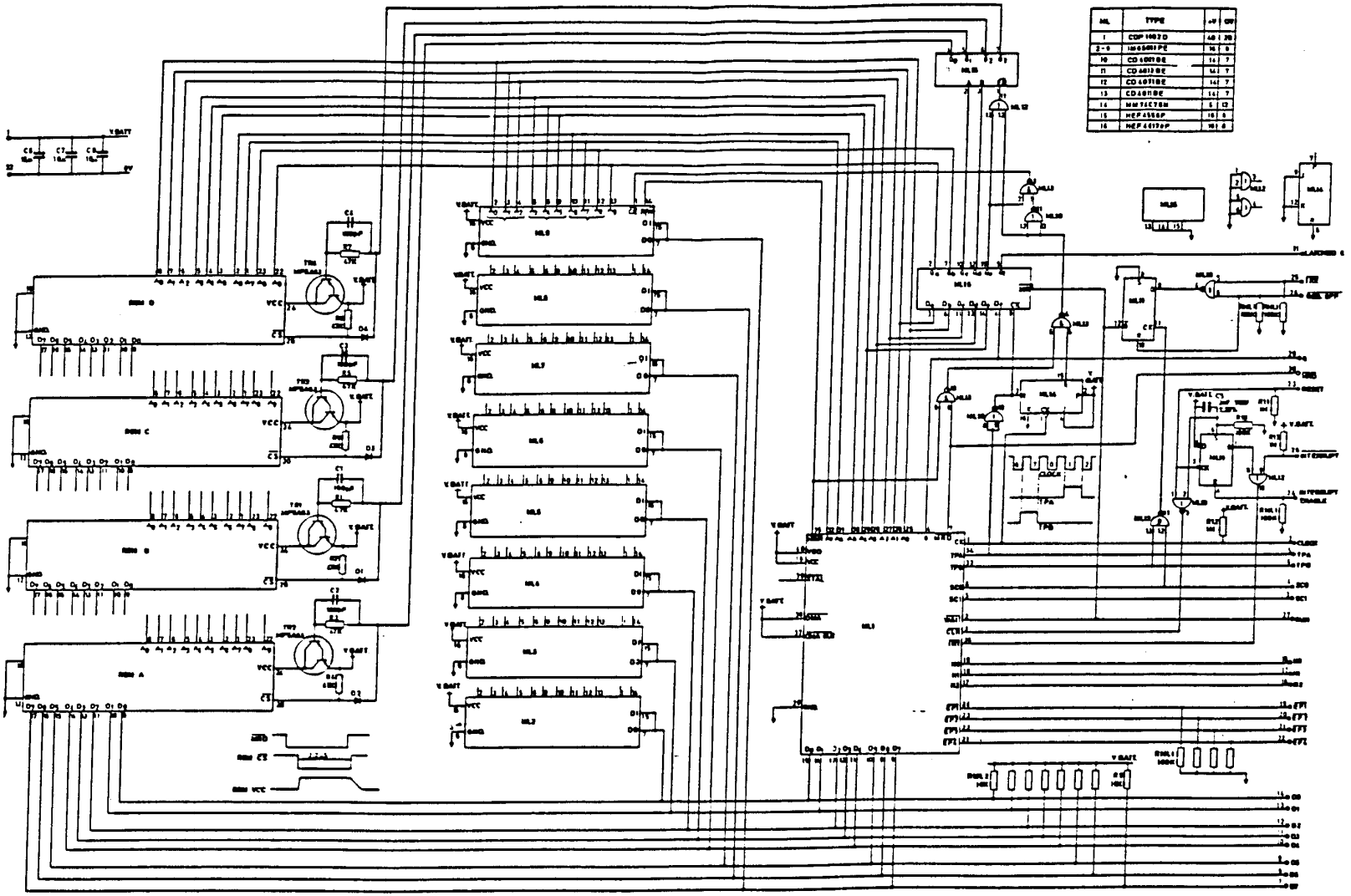
WORTHY



MA.4231 Control Board Circuit Diagram

Fig.5.3.4

R39

TABLE 1 – INTERFACE

DESIGNATION	DIRECTION	FUNCTION	PIN NO.
GND	–	Ground	32A, 32B
VEXT	SUPPLY	External power input	10B
V BATT., V BATT.	SUPPLY	Positive rail from battery	1A, 1B
RUN	INPUT	ON/OFF control signal from Display board	27A
CHAR. REQ.	INPUT	Request from Display board to output character	28B
SC01	INPUT	State Code 1 input	3A
SC02	INPUT	State Code 2 Input	4A
TPB	INPUT	Time pulse B	6A
NI	INPUT	Input/output transfer instruction	17A
BACK	INPUT	From back button on Display board (used to recall previous character(s)	21A
CLEAR	INPUT	CLEAR (RESET) from Display board	23B
MORSE	INPUT	Morse from Filter board	25B
D0	INPUT/OUTPUT	Data Bus for input and output of data	A7
D1	INPUT/OUTPUT		A8
D2	INPUT/OUTPUT		A9
D3	INPUT/OUTPUT		A10
D4	INPUT/OUTPUT		A11
D5	INPUT/OUTPUT		A12
D6	INPUT/OUTPUT		A13
D7	INPUT/OUTPUT		A14
CLOCK	OUTPUT	2.4576 MHz clock output	2A
$\overline{CTS}$	OUTPUT	Clear to send	3B
TRE	OUTPUT	Transmit register empty	4B
$\overline{BATT\ LO}$	OUTPUT	Battery low indication	15A
SIGNAL IN	OUTPUT	Signal to Control board	19A
CHAR. STROBE	OUTPUT	To Display board	19B
OUTPUT, CHAR	OUTPUT	To Control board	20A
RESET	OUTPUT	To Control board	23A
$\overline{TRE}$	OUTPUT	Transmit Register empty	25A
$\overline{INTERRUPT}$	OUTPUT	To Control board	28A
LS CLOCK	OUTPUT	307.2 kHz clock output	29B
$\overline{AUTO\ OFF}$	OUTPUT	To Display board	30B
8 UNIT	OUTPUT	Eight unit selection	22A

R40

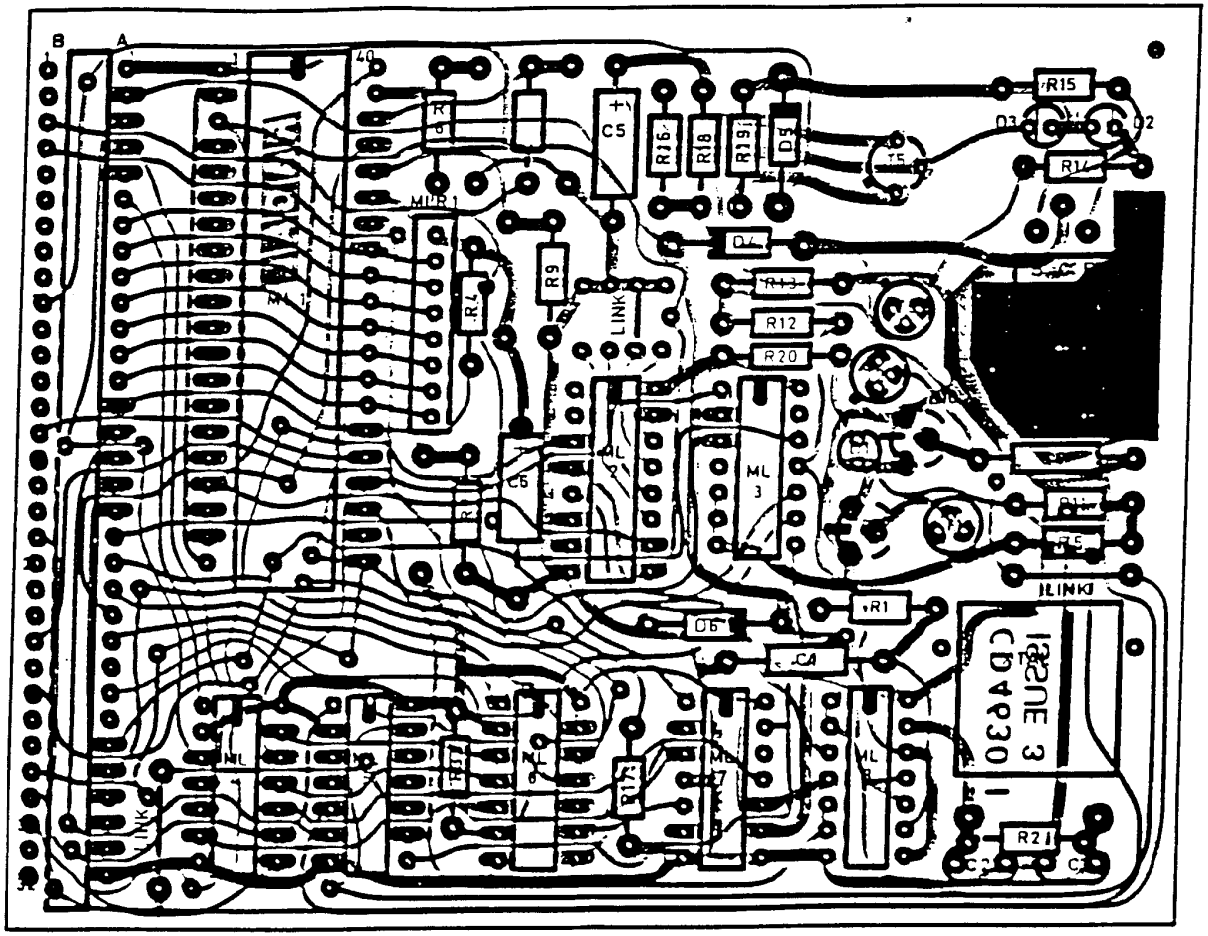


Fig. 5.4.2 MA.4231 Interface Board
P.C.B Layout

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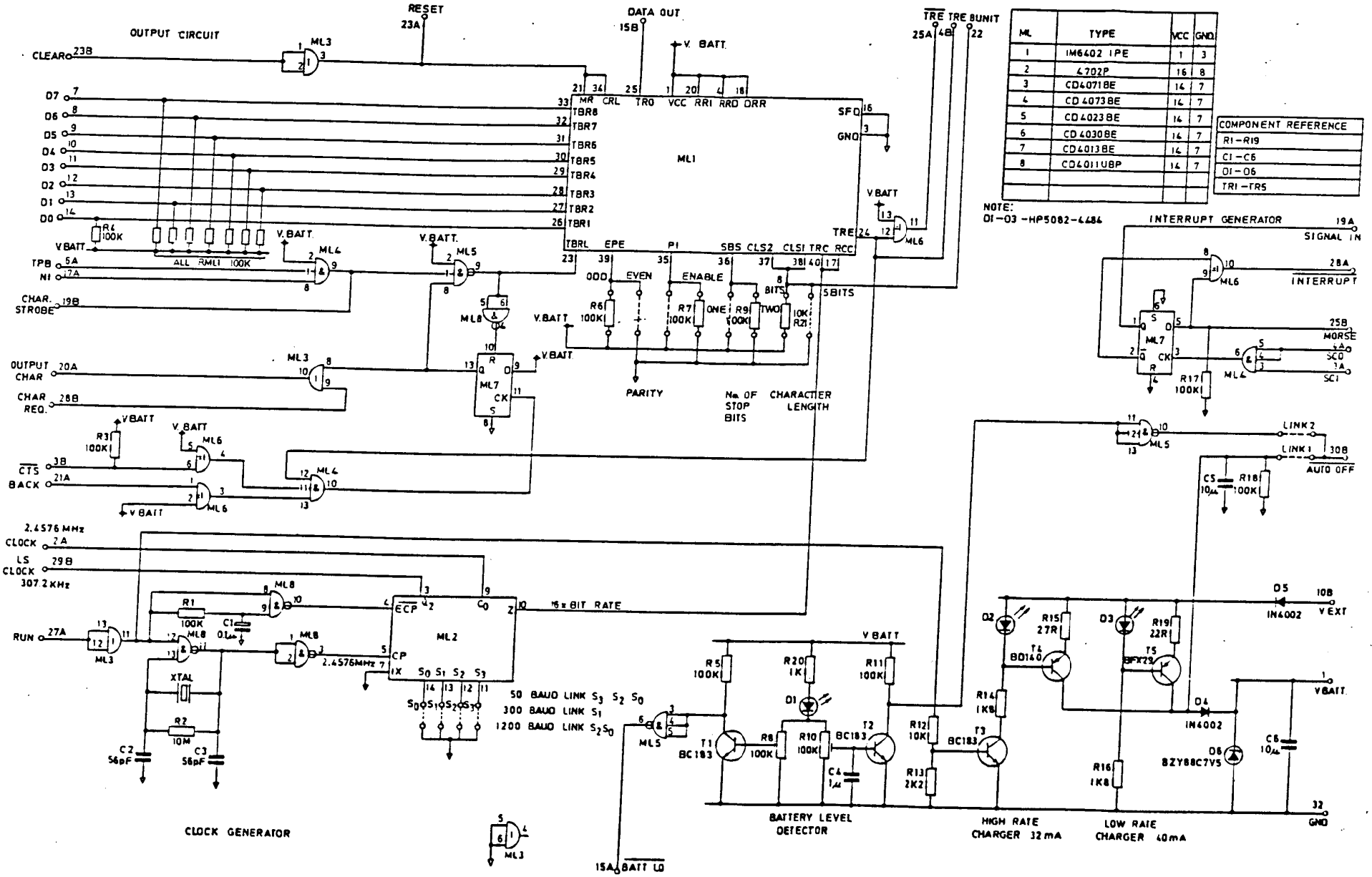
R41



ML	TYPE	VCC	GND
1	IM6402 IPE	1	3
2	4702P	16	8
3	CD4071BE	14	7
4	CD4073BE	14	7
5	CD4023BE	14	7
6	CD4030BE	14	7
7	CD4013BE	14	7
8	CD4011UBP	14	7

COMPONENT REFERENCE
R1–R19
C1–C6
D1–D6
TR1–TR5

NOTE:
D1–D3 –HP5082–4484

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WOH 8337

MA 4231 Interface Board

K42

TABLE 1 – INTERFACE

DESIGNATION	DIRECTION	FUNCTION	PIN NO.
GND	–	Ground	32
V. BATT	SUPPLY	Power supply rail	1
CTS	INPUT	Clear to send	3
TRE	INPUT	Transmit Register Empty	4
TUNE	INPUT	To TUNE l.e.d.	5
$\overline{\text{BATT LOW}}$	INPUT	Battery Low Indication	14
CHAR, STROBE	INPUT	From Interface board	19
LEVEL	INPUT	Output level indication	20
8 UNIT	INPUT	8 unit selection	22
$\overline{\text{TRE}}$	INPUT	Transmit Register Empty	25
$\overline{\text{REQ. OFF}}$	INPUT	Request off	26
RUN	INPUT	ON/OFF control signal from microprocessor	27
LS CLOCK	INPUT	Low speed clock 307.2 kHz	29
$\overline{\text{AUTO OFF}}$	INPUT	From Interface board	30
FULL	INPUT	Store Full indication	31
D0	INPUT/OUTPUT	Data bus	8
D1	INPUT/OUTPUT		9
D2	INPUT/OUTPUT		10
D3	INPUT/OUTPUT		11
D4	INPUT/OUTPUT		12
D5	INPUT/OUTPUT		13
SELECT LO	OUTPUT	Select low speed	2
$\overline{\text{RUN}}$	OUTPUT	ON/OFF control signal to Filter board	6
BACK	OUTPUT	Recall previous character	21
CLEAR	OUTPUT	RESET	23
INTERRUPT ENABLE	OUTPUT	To Control board	24
CHAR REQ.	OUTPUT	Character Request	28

K43

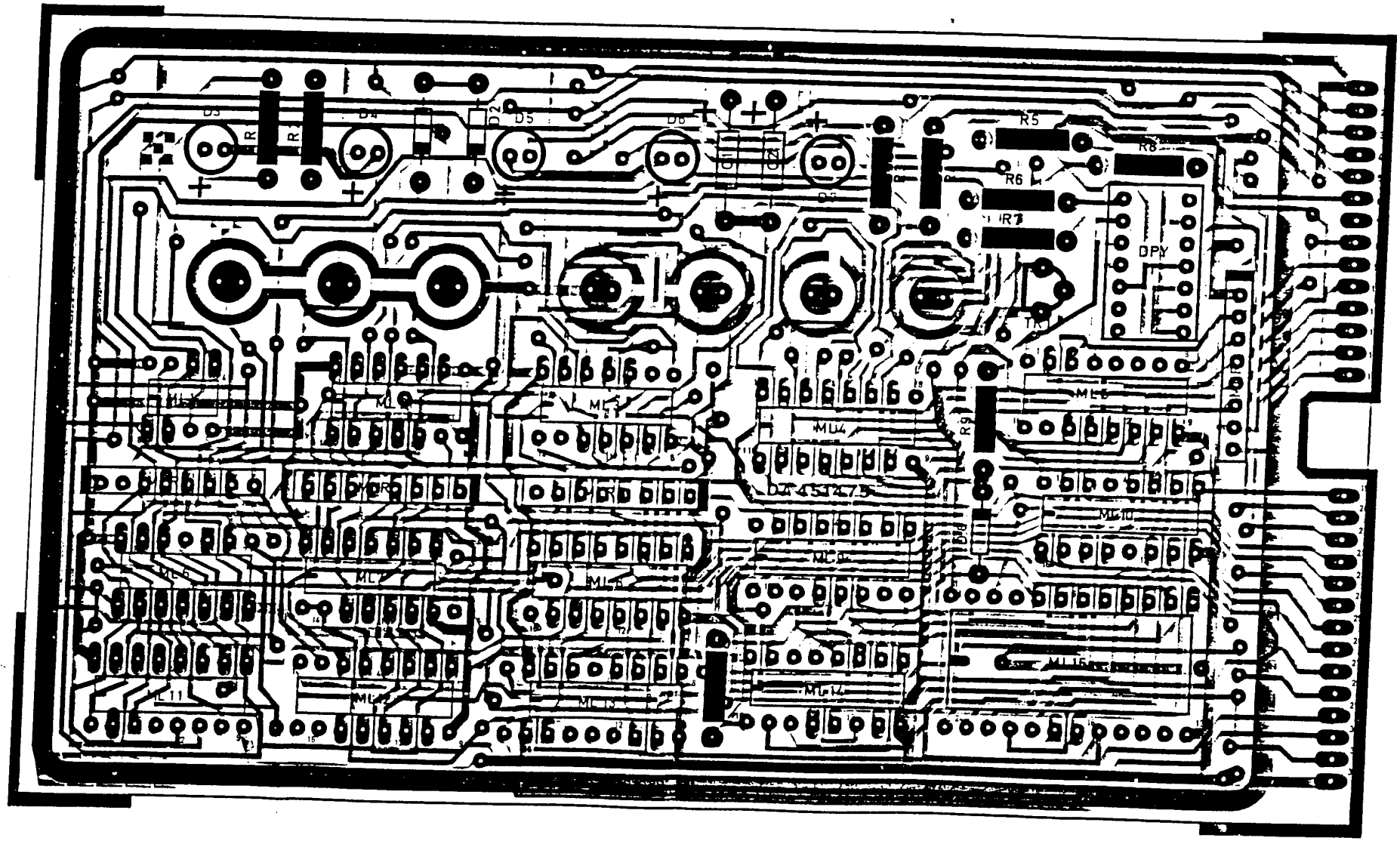
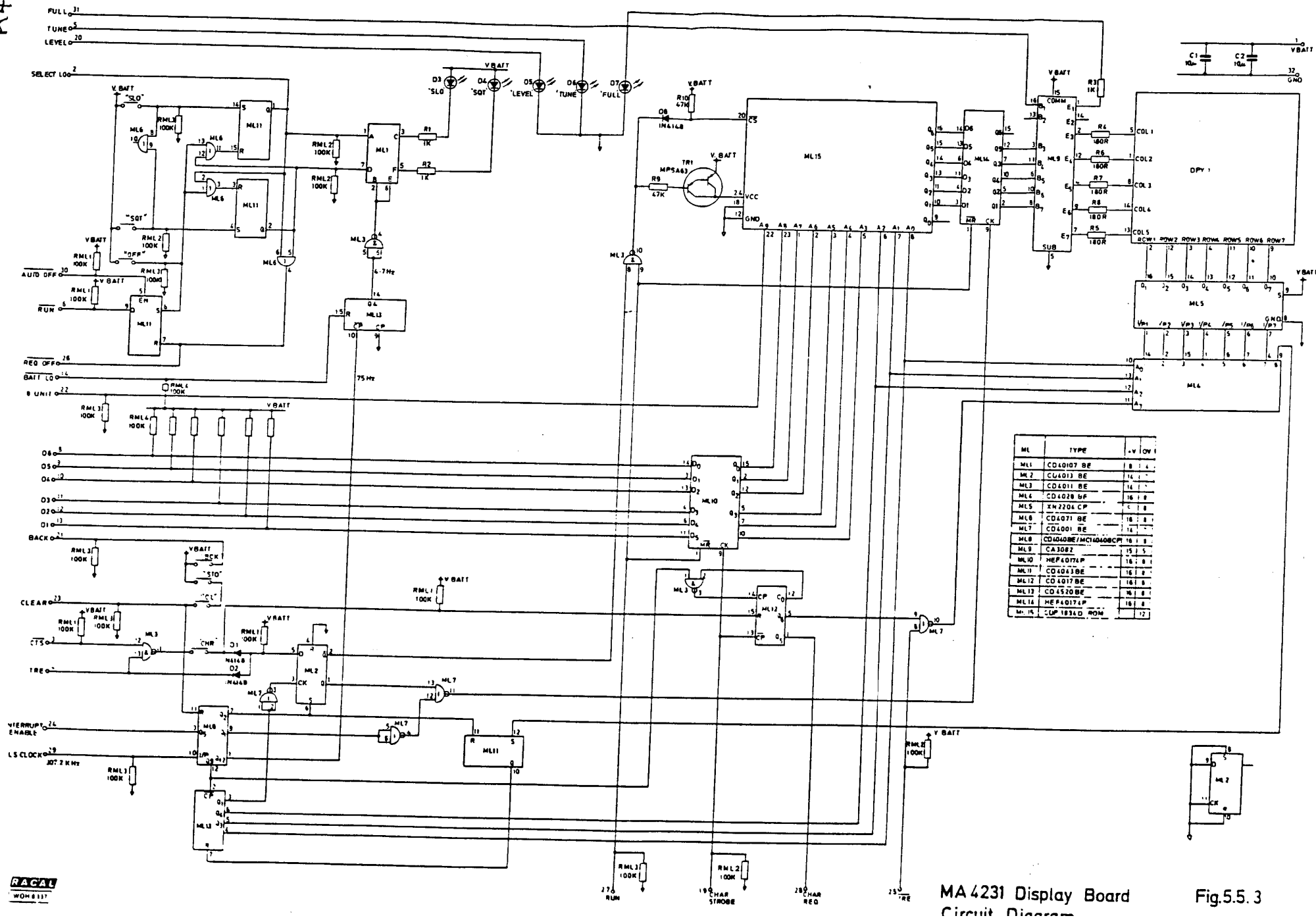


Fig.5.5.2 Display Board P.C.B. Layout

R44



ML	TYPE	+V	0V
ML1	CD40107 BE	8	4
ML2	CD4013 BE	14	7
ML3	CD4011 BE	14	7
ML4	CD4028 BF	16	8
ML5	XH2206 CP	C	8
ML6	CD4071 BE	14	7
ML7	CD4001 BE	14	7
ML8	CD4040BE/MC14040BCP	16	8
ML9	CA3082	15	5
ML10	HEF40174P	16	8
ML11	CD4043BE	16	8
ML12	CD4017BE	16	8
ML13	CD4520BE	16	8
ML14	HEF40174P	16	8
ML15	CUP 1834D ROM		12

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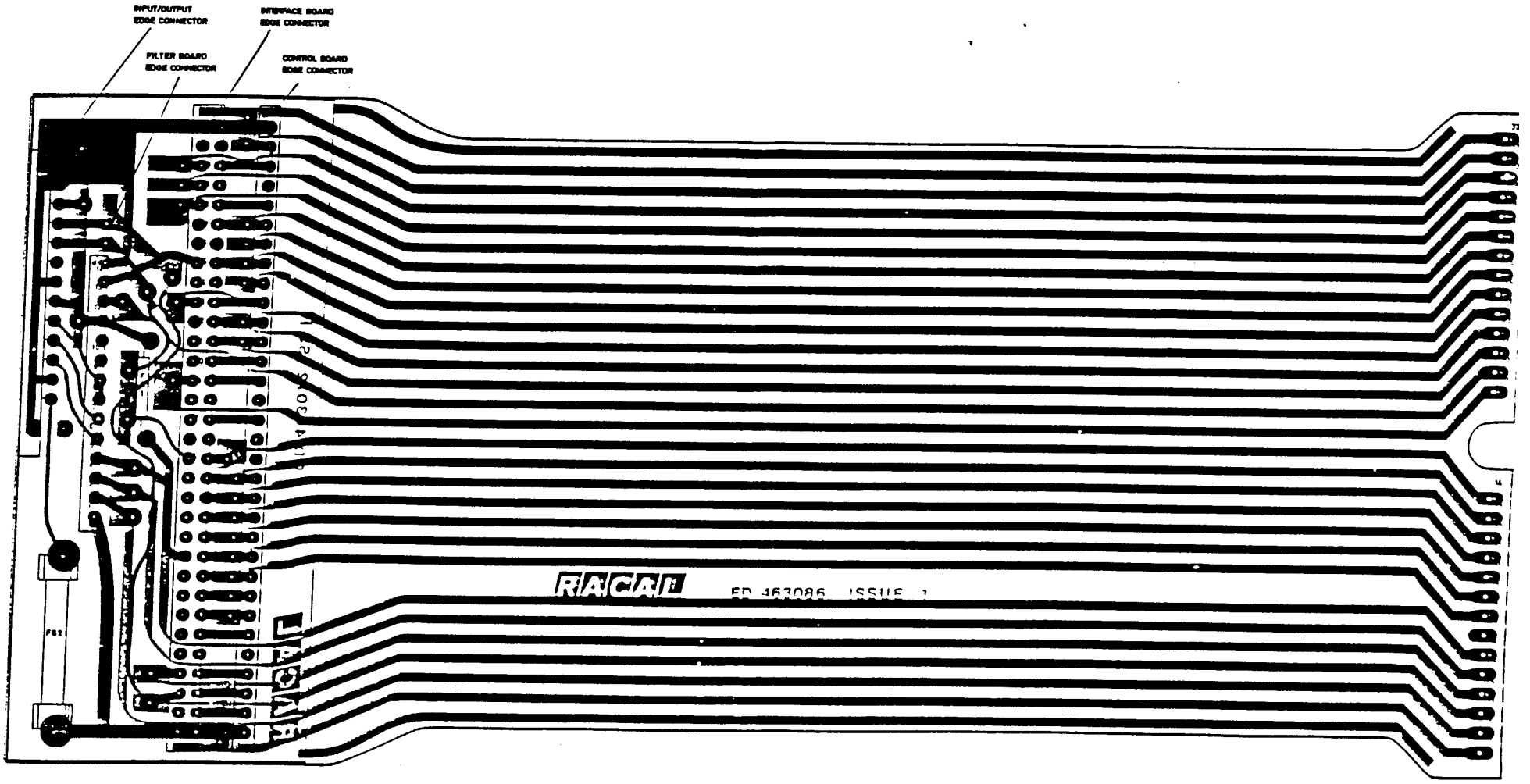
WDH 8117

MA 4231 Display Board Circuit Diagram

Fig.5.5.3

R45



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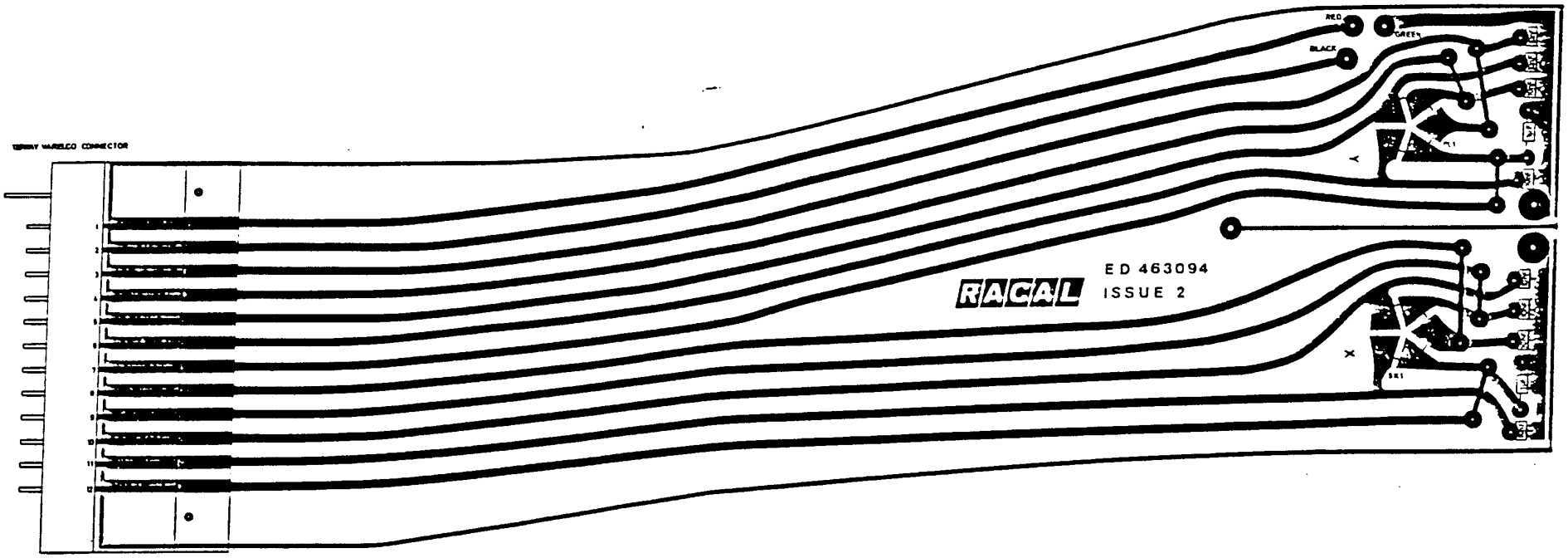
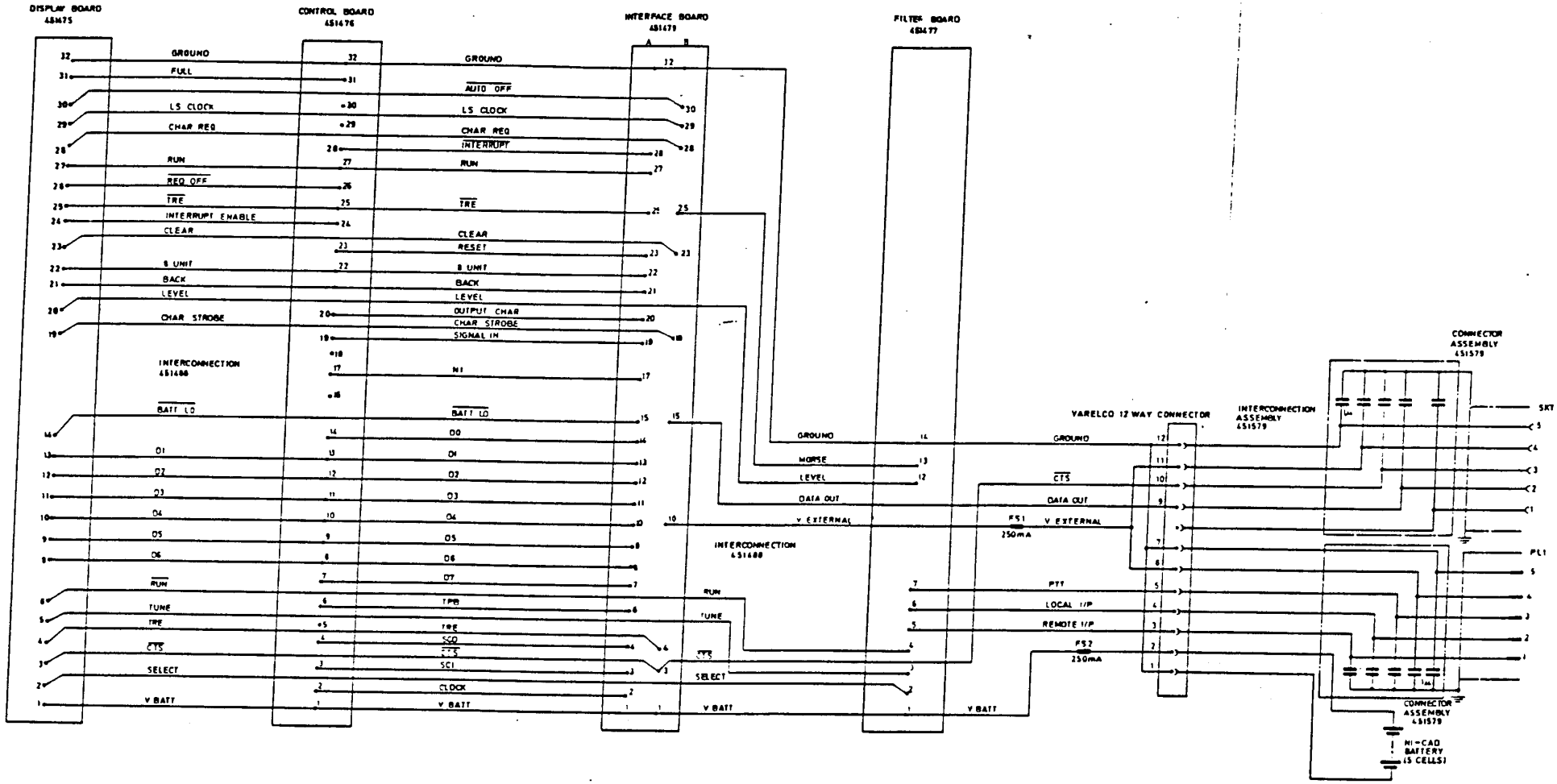
WOM 8337

Interconnection Board and Flexible
Interconnect to Display Board Fig.5.6.1


RED
GREEN
BLACK
RACAL
ED 463094
ISSUE 2

R47



NOTE: ALL CAPACITORS 10nF UNLESS OTHERWISE STATED.
ALL COMPONENTS ON DISPLAY BOARD PREFIXED 1
ALL COMPONENTS ON CONTROL BOARD PREFIXED 2
ALL COMPONENTS ON INTERFACE BOARD PREFIXED 3
ALL COMPONENTS ON FILTER BOARD PREFIXED 4

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WON 8337

MA4231 Interconnection Diagram Fig.5.6.3