Technical Service Manual

Modem Type 8580

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HEAD OFFICE

Engineering and Manufacturing

Codan Pty Ltd
A.C.N. 007 590 605
81 Graves Street
Newton, South Australia 5074
Telephone
National: (08) 336 0311
International: +61 8 336 0311
Facsimile: (08) 337 6090

INTERNATIONAL MARKETING OFFICES

Australia, Pacific and South East Asia

Codan Pty Ltd
Suite 24
818 Pittwater Road
Dee Why, NSW 2099
Australia
Telephone
National: (02) 971 2233
International: +61 2 971 2233
Telex 22631
Facsimile: (02) 982 1177

Africa, Europe and The Middle East

Codan (U.K.) Ltd
6 Grove Park
Mill Lane
Alton, Hampshire GU34 2QG
United Kingdom
Telephone
National: (0420) 8 0121
International: +44 420 8 0121
Telex 858355
Facsimile: (0420) 54 1098

North and South America

Codan Pty Ltd
Suite 101
8011 Leslie Road
Richmond BC V6X 7E4
Canada
Telephone
National: (604) 270 8332
International: +1 604 270 8332
Facsimile: (604) 270 4401

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1 General Information

1.1 Introduction

The 8580 is micro-processor controlled modem designed to bring data transmission to a range of Codan transceivers and remote control equipment.

Operating in either ARQ (automatic repeat request) or FEC (forward error correction) modes based on CCIR recommendations 476 and 625, the modem is designed to interface with the transceiver and a simple dumb terminal or a PC with the Codan 9102 Modem Controller Software.

The modem incorporates a self calibrating facility to ensure optimum performance under wide temperature variations.

The 9102 Modem Controller Software for IBM and compatible PCs provide a user friendly package supporting preparation, storage and retrieval, transmission and reception of messageses.

1.2 Specifications

Operating modes	ARQ - automatic repeat request FEC - forward error correction SELFEC - selective forward error correction
Proticol	CCIR recommendation 476 - 4 CCIR recommendation 625 mode A - ARQ mode B - FEC selective FEC - SELFEC
Modulation	Phase continuous FSK, 100 Baud
Primary voltage	12 Volts DC nominal - Negative ground. Normally supplied from transceiver
Primary power	160mA nominal
Audio input	350mV rms (22 kΩ Nominal impedance)
Audio output	350mV rms (22 kΩ Nominal impedance)
Input band width	300Hz adaptive 8-pole filter with automatic calibration
Tone frequencies	1615 and 1785 Hz. Other tones can be made available on request
Terminal interface	RS-232C, 50 to 9600 Baud
Size and weight	250mm W x 215mm D x 78mm H ; 1.5Kg

1.3 Connectors

The following details the pin connections and functions of the external connectors.

1.3.1 Terminal

Pin No.	Function	Signal Level
1	Tx 1	± 10 volts
2	Tx 2	± 10 volts
3	RTS 1	± 10 volts
4	RTS 2	± 10 volts
5	Ground	0 volts
6	Ground	0 volts
7	No connection	
8	No connetion	
9	Vcc	+ 5 volts
10	Chassis	
11	No connection	
12	Rx 1	± 10 volts
13	Rx 2	± 10 volts
14	CTS 1	± 10 volts
15	CTS 2	± 10 volts

1.3.2 Printer

Pin No.	Function	Signal Levels
1	$\overline{\text{STROBE}}$	0 - 5 volts
2	BUSY	0 - 5 volts
3	$\overline{\text{ERROR}}$	0 - 5 volts
4	$\overline{\text{ACKNLG}}$	0 - 5 volts
5	D0	0 - 5 volts
6	D1	0 - 5 volts
7	D2	0 - 5 volts
8	D3	0 - 5 volts
9	D7	0 - 5 volts
10	D6	0 - 5 volts
11	D5	0 - 5 volts
12	D4	0 - 5 volts
13, 14 & 15	Ground	0 volts

1.3.3 Transceiver

Pin No.	Function	Signal Levels
1	Ground	0 volts
2	Rx Audio	350 millivolts RMS
3	Tx Audio	350 millivolts RMS
4	Quiet Line	Output: 12 volts = On
5	Alarm	0 - 5 volts
6	PTT	Output: 0 volts = PTT
7	Scan	Input: +10 volts = Scan
8	A Rail	+ 12 volts nominal

2 Brief Description

2.1 Introduction

This description should be read in conjunction with Block Diagram 03-00623.

The main circuits of the modem are contained on two circuit boards:

(a) The Filter and Demodulator Board - containing the filter and demodulator and their associated circuits.

(b) The Microprocessor and Control Board - containing the microprocessor and its associated circuits.

The modem is connected to the transceiver via the transceiver's Option PS connector. Connections to a computer terminal and a printer are made by further connectors on the back of the modem. In the receive mode the modem receives data from the transceiver in the form of FSK signals nominally of 1785Hz and 1615Hz, i.e 1700 +/- 85Hz. In the transmit mode the modem converts data from the computer terminal to FSK signals which it sends to the transceiver.

2.2 Self Calibration

A self calibration procedure is initiated when the modem is switched on. The procedure can also be initiated from the computer keyboard if required.

When the procedure is initiated the microprocessor, IC1, centres the two bandpass filters, IC1 and IC2, on the Filter and Demodulator Board on the centre frequency of the FSK signals and sets the bandwidth of the filters. (Provision is made for two further filters, IC3 and IC4, which are not used in this application.)

At the same time the tone generator, IC12, under the control of the microprocessor, sends a tone at the centre frequency of the FSK signals to the input mixer, IC5/A, on the Filter and Demodulator Board. The output of the mixer is connected to the input of the phase locked loop (PLL), IC6, and the resulting output is taken to the frequency integrator IC9/A. The microprocessor compares the output of the integrator with a frequency reference from the PLL. The microprocessor then varies the control voltage to the VCO in the PLL to bring the difference in the two frequencies to zero.

2.3 Receive Path

The audio output from the transceiver is connected to the filter input so that the FSK signals are passed while noise and signals outside the passband are rejected. The FSK signals are sent, via the input mixer to the PLL. The FSK signals are demodulated in the PLL and the resulting data is passed to a data filter, IC9/B, which removes any remaining noise from the data. A squarer, IC10/D, improves the waveshape before passing the data to the microprocessor via an analogue switch, IC8/B. (IC8/B is associated with the extra filter, IC3 and IC4, and remains closed when this is not fitted, as in this application.)

The data is decoded in the microprocessor. The decoded data can be taken to an RS232 input/output device, IC15, for conversion and connection to the computer terminal, or via a UART, IC13, and a latch, IC14, for connection to the printer. Both outputs can be used simultaneously if required.

2.4 Transmit Path

As the data is typed, or a file is read, at the computer terminal the data is applied, via the Terminal connector, and IC15, RS232 input/output device to the microprocessor. The microprocessor controls the tone generator via the data bus to output the two FSK tones corresponding to the data to be transmitted. The FSK tones are connected to the transceiver together with a PTT signal generated by the microprocessor.

2.5 Microprocessor

2.5.1 Parallel Bus

The microprocessor is connected to most of the other devices on the board via a parallel 8-bit data, 16-bit address bus. A PLD, IC8, on the bus decodes the higher order address bits to select other devices on the bus. The tone generator, IC12, the UART, the IC13, the latch, IC14, and RS232 input/output device, IC15, are controlled via the bus. The control programme is contained in an EPROM on the bus. A RAM, also on the bus, supplements the microprocessor's internal RAM.

2.5.2 Serial Bus

The microprocessor is connected to an EEPROM, IC10, and an output expander, IC7, via an I^2C serial bus. The EEPROM stores user-defined parameters which can be set at the keyboard. The output expander deals mainly with hardware configurations set on a row of DIP switches on the board.

2.5.3 Reset Circuit

The reset circuit, IC11, monitors the power supply voltage and resets the microprocessor if the voltage falls below a preset level.

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3 Technical Description

3.1 Introduction

3.1.1 Printed Circuit Boards

The circuits of the modem are on two printed circuit boards:

(a) Filter and Demodulator Board	Assembly Drawing Circuit Diagram	08-03937 04-02567
(b) Microprocessor and Control Board	Assembly Drawing Circuit Diagram	08-03706 04-02438

3.1.2 Chassis and Interconnections

The metal chassis containing the printed circuit boards has a connector on its rear panel for connection to the Option PS connector of a transceiver. A further connector on the rear panel provides the Option PS facility so that equipment normally connected to the PS connector on the transceiver may be connected via the modem. Interconnections between the rear panel PS connectors and the Filter and Demodulator Board are made by a cable. Connectors for a computer and a printer connected directly to the Microprocessor and Control Board are mounted on the rear panel. Interconnections between the two printed circuit boards are made by ribbon cables. A single LED indicator is mounted on the front panel and is connected to the Microprocessor and Control Board by a short cable.

3.2 Power Supply Regulators

3.2.1 12V DC supply

(Ref 04-02567)

Power for the modem is derived from the 12V DC supply to the transceiver to which the unit is connected. The supply is connected to P4 from the Option PS connector of the transceiver; positive to pin 8, and negative to pin 7 (ground). Diode D9 provides protection against reverse polarity. Capacitor C32 and inductance L2 decouple RF picked up on the connecting cable. The decoupled supply (A rail) is used by transistors V1, V2 and V3 on the Filter and Demodulator Board. A test point, TP5 (marked A RAIL) is provided on the rail.

3.2.2 10V Regulator

A regulated 10V supply (B rail) for the remainder of the circuits on the Filter and Demodulator PCB is derived from the A rail by regulator IC7. A test point, TP3 (marked B RAIL), is provided on the output of the regulator.

3.2.3 5V Regulator
(Ref 04-02438)

The A rail is also taken, via P2 pin 5, to the Microprocessor and Control PCB. Entering the board at P5 the supply is used by IC6 to provide a regulated 5V supply.

3.3 Self Calibration

3.3.1 Introduction

The data signals are received as frequency shift keyed (FSK) audio tones normally of 1785Hz and 1615Hz, ie 1700 +/- 85Hz. The received audio signals are filtered and then decoded by a phase locked loop. A self calibration procedure, which sets the filters and the phase locked loop to the centre frequency, is automatically initiated when the modem is switched on.

The procedure is controlled by the microprocessor and can also be initiated from the computer keyboard if required. When the procedure is automatically initiated at switch on, the filter and phase locked loop are set to the default frequency (1700Hz). Using the computer keyboard the circuits can be set for other frequencies within a small range. Greater changes can be obtained by changing the value of R29 on the Filter and Demodulator PCB.

3.3.2 Band Pass Filters
(Ref 04-02567)

On the Filter and Demodulator PCB two switched capacitor filters, IC1 and IC2, form the band-pass filter. (Provision is made for two further filters, IC3 and IC4, which are not used in this application.) A clock input from the Microprocessor and Control PCB sets the centre frequency of the filter. Data loaded to pins 1, 2, 3, 17 and 18 of the ICs, sets the Q of the filter. The two ICs are cascaded providing an 8-pole (sharp cut off) bandpass filter. (Normally 300Hz wide.)

When the self calibration procedure is initiated the microprocessor sets the clock frequency connected to the switched capacitor band-pass filters, to centre the filter on the required frequency. The division factor of the filters is set to 50 (pin 11 of both filters connected to ground) so the clock frequency is set to 50 times the required frequency. At the same time the microprocessor loads data to set the appropriate Q for the filter.

3.3.3 Phase Locked Loop

The microprocessor also sends the required data to the tone generator, IC12, on the Microprocessor and Control PCB, to generate the centre frequency of the FSK signals to be received (normally 1700Hz). This is connected to the Filter and Demodulator PCB on P3 pin 9 (FSKO). The signal is connected via C46 and R17 to the summing amplifier formed by IC5/A and its associated components. The output of the summing amplifier is connected to the input of the phase locked loop, IC6. At this time there are no other inputs to the summing amplifier and the filters are disabled, so that the only input to the phase locked loop is the reference centre frequency.

The frequency of the VCO in the phase locked loop is set by the capacitor C17 and the voltage connected to pin 12. The difference in the DC voltage at the output, pin 11, and the reference voltage, pin 10, is proportional to the difference in the frequency at the input, pin 2, and the frequency of the internal VCO. The two voltage levels are connected to A to D converters in the microprocessor; the reference level to AD1 and the output voltage to AD2. The microprocessor compares the two voltages and outputs a pulse-width modulated signal, PWM, the mark:space ratio of which is proportional to the difference in the voltages. The PWM signal is integrated by D1, C18 and R30 to produce a voltage which is connected to pin 12. The microprocessor adjusts the mark:space ratio of the PWM signal, and consequently the control voltage, to reduce the difference voltage to zero, thus setting the VCO to the required frequency.

Test points TP8 and TP2 are provided for measurement of the output voltage level and the reference level respectively.

3.4 Receive Audio Path

3.4.1 Band Pass Filters and Mixing Amplifier

The received audio FSK tones (normally 1785Hz and 1615Hz) from the receiver are connected to P4 pin 6 and are taken to the band-pass filter, IC1 and IC2. The filters are enabled in the receive mode. The output from the filter is connected to the summing amplifier formed by IC5/A and its associated components. For normal reception no other inputs are connected to the amplifier.

3.4.2 Phase Locked Loop

The output from the summing amplifier is connected to the input of the phase locked loop IC6. Since the output on pin 11 is proportional to the difference in frequency between the incoming signal and the VCO, the output represents the decoded data.

The lock detect output and the associated comparator, IC9/B, are not used in this application.

3.4.3 Data Filter and Bit Slicer

The data output from the phase locked loop is connected to the data filter formed by IC9/B and its associated components. This is a low-pass filter at approximately 80Hz which passes the resulting data to the input of a comparator, IC10/A, and to the bit slicer formed by D6, D7, C49, C50, R55 and R56. The bit slicer integrates the data signal to give a DC level equal to the mean level of the signal. This is connected to the inverting input of the comparator. Consequently the output from the comparator follows the data pulse output to switch on and off the transistor V5.

The collector circuit of V5 is taken to the Microprocessor and Control PCB via analog switch, IC8/B, and P2 pin 7 (FSK1). IC8/B is held on in the receive mode. On the Microprocessor and Control PCB (04-02438) the collector output is taken to the microprocessor, IC1, port P1.0. This port is internally held to the high logic level so that when the transistor is switched off the input to the microprocessor is a logic 1, when the transistor is switched on it pulls down the input to give a logic 0.

3.4.4 Microprocessor and Data Output

The serial data received in this way is decoded in the microprocessor and sent out as parallel data on the data bus, ports P0.0 to P0.7. When the microprocessor has a character to send to the terminal, it writes the character out on the data bus. It then selects the UART, IC13, by setting its address, chip enable (CE) and write strobe (WR) lines.

3.4.5 Terminal Interface

The UART converts the parallel data to serial data and sends it out on the TX2 line to the RS232 input/output device, IC15. IC15 translates the TTL levels of the data to the +/-10V levels required by the RS232 interface. The level-translated data is then sent out on the T2OUT line to the computer terminal via P1 pin 2. The output line is decoupled by C7 and part of R25.

3.5 Transmit Audio Path

3.5.1 Data From Terminal to Microprocessor

As the message is typed, or the file is read, from the computer terminal the serial data is connected to the Microprocessor and Control PCB on P1 pin 13, and taken to the input/output device, IC15. The input is decoupled by C10 and part of R26. IC15 translates the RS232 levels to TTL levels and sends them on the RX2 line to the UART, IC13. The UART converts the serial data to parallel data and prepares to apply it to the data bus, D0 to D7. When a complete word is ready for application to the data bus the UART sends an interrupt to the microprocessor. The microprocessor connects the UART address to the address bus and activates the Chip Enable (CE) and Read (RD) lines so that the word is read via the data bus by the microprocessor.

3.5.2 Tone Generators

The microprocessor processes the parallel data from the UART and converts it into serial data. For each bit of the serial data the microprocessor selects the tone generator, IC12, and sends a data word to the device to set the factor by which it will divide its clock input. This causes the tone generator output on pin 10 to be either a 1785Hz or a 1615Hz tone corresponding to 0s and 1s in the data. The tone generator output is connected to P6 pin 9.

3.5.3 Audio Data Output

When the modem is processing data the microprocessor outputs a high logic level, S/ARQ, on Port P4.4. This is taken, via P6 pin 5, to the base of transistor V2 on the Filter and Demodulator PCB to turn on the transistor, energising relay K1. With the relay energised the contacts of K1 connect the ALMB and FSK0 functions to the ALRMA and TXA connections, respectively, of the transceiver. When the modem is not in use the relay is de-energised and the ALMA and TXA connections from the transceiver are taken to the corresponding connections of the equipment connected to the Option PS connector.

The FSK signals from the tone generator are connected to the Filter and Demodulator PCB on P3 pin 9 and filtered by C10, C11, R20 and R52 to improve the wave shape. Since relay K1 is energised the FSK tones are then taken to P4 pin 5 for connection to the audio input of the transceiver via the Option PS connector. The line is decoupled by a resistor, part of R39, and capacitor C30.

3.6 Microprocessor and Control

3.6.1 Introduction

Circuits on the Microprocessor and Control PCB govern the functions of the modem and the connected computer and printer. The microprocessor on the board accepts inputs from within the modem and from the connected computer. Under the control of the programme in the EPROM it outputs the data necessary to achieve the appropriate response to input signals.

The microprocessor is connected with other devices on the board by two busses: a conventional microprocessor bus (8-bit data, 16-bit address) and an 'Inter-Integrated Circuit' (I^2C) bus.

3.6.2 Microprocessor

The microprocessor IC1, is a PCB80C552 which is based on the Intel 8051 8-bit microprocessor family. It has internal ROM, internal RAM, two standard timer/counters, an additional timer/counter coupled to four capture registers and three compare registers, an A to D converter, two pulse-width modulated outputs, five 8-bit I/O ports, one I^2C serial I/O port, a UART and an internal watchdog timer.

3.6.3 Parallel Bus

The microprocessor parallel bus operates in a conventional 8-bit data, 16-bit address configuration. To minimise the pin count, the lower order address bits are multiplexed with the data on pins 50 to 57 onto a common 8-bit bus. IC3 is used to latch the low order address bits to facilitate access to the external non-multiplexed devices. The Address Latch Enable (ALE) signal (IC1 pin 48) indicates to the latch when the address on the bus is valid. The higher order address bits are provided directly on pins 39 to 46 of IC1.

The following external devices are connected to the bus:

(a) IC8 - A PLD which decodes the higher order address bits to select the other devices on the board.

(b) IC5 - An EPROM containing control software. The microprocessor reads the EPROM via the Programme Store Enable (PSEN) signal (pin 47) which is used as a Read strobe.

(c) IC4 - A RAM device supplementing the microprocessor's internal RAM. It is accessed via the Read (RD) or Write (WR) strobes (IC1 pins 31 and 30) in conjunction with address bus and CS1 via IC8.

(d) IC12 - A triple tone generator used to generate the tones for the FSK signals for transmission, the single tone for the self calibration procedure and the clock frequencies for the switched capacitor filters. Three audio tone outputs are generated within IC12 by dividing the clock inputs on pins 9, 15 and 18 by factors programmed into its data input. The clock inputs are derived from the microprocessor's own clock via a divide by 2 circuit, IC2.

(e) IC13 - A UART which converts parallel data from the microprocessor to serial data for the RS232 interface in the receive mode and converts the serial data from the interface to parallel for the microprocessor in the transmit mode. The three lowest order address lines are used to select one of the UART'S eight internal registers for processing the eight bits on the data lines.

(f) IC14 - An 8-bit latch which drives the printer port.

3.6.4 I²C Bus

The microprocessor I²C bus consists of a clock and a data line. The data line carries the address and data bits serially with their transfer being synchronised by transitions on the clock line. The following devices are connected to the bus:

(a) IC7 - An output driver with five functions:

(i) An output from Port P1 lights the LED on the front panel indicating that the microprocessor is operational.

(ii) An output from Port P2 lights the status indicator, H1, on the board.

(iii) DIP switches, S1, are connected to ports P3 to P10. The hardware configuration (Baud rates, etc) to be used by the modem is set by these switches. In its initialisation routine the microprocessor polls the setting of each switch in turn by putting a low logic level on the associated port. If the switch is closed the input to port P5.0, IC1 pin 1, is taken low. If the switch is open the port remains high. (Settings for these switches are given in the Operating Instructions, Section 4, of this manual.)

(iv) Port P11 controls an analogue switch on the Filter and Decoder PCB. (Not used in this application.)

(v) Ports P12 to 16 output the data word that sets the bandwidth of the switched capacitor filters.

(b) IC10 - An EEPROM which provides 256 bits of non-volatile memory. This is used to store the user-defined parameters of the modem which are set via the computer terminal and the hardware configuration switches. The hardware configuration switch settings will override the EEPROM settings if the hardware configuration switch 7 is off.

3.6.5 Low Voltage Reset

IC11 monitors the 5V (Vcc) supply and gives a Reset output to the microprocessor if the supply voltage falls below 4.7V. It holds the microprocessor in the reset state until the voltage rises to 4.8V so that the microprocessor then goes through its initialisation routine.

3.6.6 Watchdog

The EW input to the microprocessor, IC1 pin 6, is held low so that the internal watchdog circuit is enabled.

3.6.7 RS232 Terminals

Serial data and controlling signals from the UART are connected to an RS232 inout/output device, IC15, where the TTL levels from the UART are changed to the +/-10V required by the RS232 interface. Line drivers in the IC provide the necessary power. Each output is decoupled by a capacitor, C18, C7, C5 and C6 and a 1kilohm resistor, part of R25.

Similarly incoming data from the interface is converted by the input/output device from +/-10V levels to the TTL levels required by the UART.

Provision is also made for a further interface directly with the microprocessor. This is for possible future use.

3.6.8 Parallel Printer Port

8-bit parallel data from the microprocessor is connected to the 8-bit latch, IC14, for application to the printer over a Centronics interface. Printer status data is taken to the microprocessor via schmidt triggers IC9/A, IC9/B and IC9/C. When the printer is ready each word is sent to the printer by a printer strobe via a further schmidt trigger, IC9/D.

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4 Operating Instructions

See User Guide located in the rear pocket of this Technical Service Manual.

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5 Maintenance

5.1 General

5.1.1 CMOS Devices

A number of Complementary Metal Oxide Semiconductor (CMOS) devices are used in the modem. Although protection is built into most of these, their extremely high open-circuit impedance makes them susceptible to damage from static charges. Care must, therefore, be used when shipping and handling the devices and in servicing equipment in which they are installed. The following precautions should be observed:

(a) Packaging - Replacement CMOS devices are supplied in special conductive packaging. They should be left in this packaging until required for use.

(b) Switch Off - Ensure that supplies are switched off before disconnecting any connections between circuit boards and the remainder of the modem.

(c) Handling - Handling circuit boards and particularly touching any conductive parts should be kept to a minimum.

(d) Grounding - Anything connected to, or touching, the circuit board tracks should be grounded. Observe the following:

   (i) Test equipment connected to a board should be grounded via its mains lead.

   (ii) Static charges which may build up on the person can be discharged by touching a grounded metal surface with both hands.

   (iii) Wearing a suitably grounded conductive wrist strap will minimise the static build up on the person.

5.1.2 Circuit Boards

When servicing printed circuit boards the following should be observed:

(a) Excessive heat - Excessive heat may lift the track from circuit boards, causing serious damage. Avoid the use if high-powered soldering irons: a 60W maximum iron, preferably temperature-controlled at approximately 370°C, is sufficient for most tasks. A slightly higher temperature (425°C) iron may be required for heavier components such as power transistors. Apply the iron only long enough to unsolder an existing joint or to solder a new one.

(b) Unsoldering - When unsoldering use a solder sucker or Solderwick to remove solder. DO NOT USE SHARP METAL TOOLS SUCH AS SCREWDRIVERS OR TWIST DRILLS AS THESE WILL DAMAGE THE PRINTED CIRCUIT TRACK.

(c) Component substitution - Avoid unnecessary component substitution as this may damage the component, the circuit track or adjacent components.

(d) When a component is diagnosed as defective, or the fault cannot be diagnosed in any other way than replacement:

(i) Axial leads - Components with axial leads, e.g. resistors and tubular capacitors, can often be replaced without unsoldering the joints on the boards. The defective component can be removed by clipping its leads close to the component, leaving the leads soldered to the board. These leads should be straightened so that the leads of the replacement can be wrapped around them and soldered. After soldering, the excess lead should be clipped off.

(ii) Remove solder - When a component has been unsoldered from the board ensure the holes are clear of solder before inserting the leads of the replacement. ON NO ACCOUNT FORCE THE LEADS THROUGH THE HOLES AS THIS WILL DAMAGE THE CIRCUIT TRACK PARTICULARLY WHERE PLATED-THROUGH HOLES ARE USED.

(iii) Observe orientation - When replacing diodes, transistors, electrolytic capacitors or integrated circuits, before removing the defective component, observe any marking indicating polarity or orientation. It is essential that these types of components are installed with the correct connections. If necessary consult the manufacturer's data for indications of the polarity of diodes or capacitors and connections of transistors.

(iv) Heat sinking - Whenever possible use long-nosed pliers or some other form of heat sinking on the leads of heat-sensitive components while soldering them to the board.

(v) Thermal conduction - When replacing transistors which are mounted on heat sinks ensure good thermal conduction between the heat sink and the replacement by cleaning the mounting surfaces and recoating them with a thermal conduction compound such as Jermyn Thermaflow A30.

(e) Track repair - Broken or burned sections of printed circuit track can be repaired by bridging the damaged section with tinned copper wire. The section where the repair is to be made must be cleaned observing the precautions outlined in (b) above before soldering.

(f) Integrated circuit replacement - In some cases it is possible to desolder and remove components from the board without damage to the component or board. However, integrated circuits with a large number of connections, mounted on double-sided circuit boards with plated-through holes are almost impossible to remove intact, and the operation is likely to damage the circuit boards. To replace these components their leads must be cut individually until the body of the component can be removed from the board. Individual leads must then be unsoldered and removed (refer to (d) (ii) above) before inserting the replacement component.

5.1.3 Probe Precautions

The following should be observed when connecting CRO probes to the modem:

(a) To reduce stray pick-up the earth clip lead should be wound around the body of the probe so that the earth clip just reaches the probe tip.

(b) The earth clip should be connected to the ground connection immediately adjacent to the point of measurement to which the probe tip is connected.

(c) Earth loop problems may be caused if two probes are connected with their earth connections made to different boards.

(d) Probes should be connected after power has been applied to the modem and the test equipment. Earth connections should be made first and disconnected last.

5.2 Dismantling and Re-assembling

5.2.1 General

It may be necessary to remove printed circuit boards from the modem in order to carry out certain repairs. The paragraphs which follow give instructions for the removal and re-installation of boards. While carrying out these the following general points should be observed:

(a) Screwdriver - Posidrive head screws are used in almost all locations. Ensure the correct size screwdriver is used.

(b) Connectors - The ribbon cable header and multiway connectors used in some locations. Care must be taken when re-installing to ensure that these connectors are correctly mated.

5.2.2 Top And Bottom Covers

To gain access to the Microprocessor and Control Board, only the top cover need be removed. For access to the Filter and Demodulator Board only the bottom cover need be removed. To remove either cover, the two screws (one on each side) must be removed and the rear edge of the cover lifted and drawn back so that the front edge is released from the panel surround.

When re-installing a cover, it should first be placed on the unit with its front edge and sides inserted under the lip of the panel surround. The front edge should be slid forward under the panel surround then the rear edge pressed down so that the retaining screws can be re-inserted and tightened.

5.2.3 Circuit Board Removal

To gain access to the solder side of the Filter and Demodulator Board the inter-connecting cables must be disconnected and the four retaining screws removed. The board can then be removed.

The connectors on the Microprocessor and Control Board which are also secured to the rear panel, make removal and re-installation of this board more difficult. To gain access to the solder side of the board it is often more convenient to remove the septum (complete with the Filter and Demodulator Board). To do this, first remove the screws retaining the Microprocessor and Control Board to the septum and disconnect the cables interconnecting the boards. Then remove the single screw retaining the septum to the rear panel and the four screws which retain it on the brackets inside the case.

5.3 Fault Diagnosis

5.3.1 General

The removal and substitution of components may damage the components and/or the printed circuit boards. In some cases it is impossible to remove components without destroying them. It is important, therefore, to carry out as much fault diagnosis as possible with components in situ. Specific tests are described later in this section. The general points which follow should also be of assistance:

(a) Spare boards - If spare boards are held in stock, they may be substituted in order to positively localise the fault to one board.

(b) Transistor tests (static) - Transistor failures are most often due to open-circuit base-emitter or base-collector junctions, or a short-circuit between emitter and collector.

These types of faults can often be detected without removing the transistor, using the ohms range of a multimeter. The two junctions should both give the appearance of a diode, i.e. high resistance with the multimeter leads one way round and low resistance when the leads are reversed. (Polarity depends on the whether a PNP or NPN transistor is being tested.) Resistance between collector and emitter should be high with the multimeter leads either way round. The circuit diagram should be examined for parallel paths before a transistor failing these tests is removed.

(c) Transistor tests (dynamic) - Some transistor faults can be diagnosed by measuring voltages within the circuit. One of the most significant voltage measurements is the base-emitter voltage. The polarity of this will depend on the type of transistor (PNP or NPN). A base-emitter voltage between 0.5 and 0.9V should be measured on a forward-biased base-emitter junction.

With the base-emitter junction forward biased the transistor should conduct. Some indication of satisfactory operation of the transistor can be obtained by measuring the voltage drop across its collector or emitter resistor and short circuiting its base to the emitter. The short circuit will remove the forward bias cutting off the transistor so that the voltage across the resistor will be considerably reduced.

(d) Integrated circuits - If there appears to be no output from an integrated circuit, before replacing the device, it should be ascertained whether the fault is due to the IC or its load. As a general rule, if changes in input cause absolutely no changes in the corresponding output the IC should be suspected. If, however, even a very small change in output can be detected the load is more likely to be the cause. Depending on the circuit, further tests should be made by disconnecting the resistors, capacitors, etc to verify this diagnosis before removing the IC.

5.3.2 System Checks

Before trying to diagnose a fault in the modem it should be ensured that the associated transceiver is functioning satisfactorily. Reception of FSK signals can be heard on the audio output of the transceiver. Transmission by microphone should be verified. If both of these functions are satisfactory the fault is most likely to be in the modem, but the connections between the Option PS connector and the reception and transmission functions of the transceiver should not be overlooked.

To establish the faulty modem within a system, select the FEC mode between two terminals. (Refer to operating instructions.) By transmitting from each terminal in turn it can be established which modem fails to decode data. Transmission and reception can be verified by the methods outlined above.

NOTE. If both terminals operate satisfactorily in the FEC mode one terminal may be incorrectly set for the ARQ mode. Refer to the operating instructions for the setting up procedure.

5.3.3 Voltage Measurement

The circuit diagrams show the voltages that should be present at various points to enable the faulty section of the modem to be located. The voltages listed below should always be verified first:

(a) Supply voltages on the Filter and Demodulator Board can be measured with respect to Test Point 6 GROUND:

  (i) TP5 (A RAIL) Battery voltage: nominally 12V.

  (ii) TP 3 (B RAIL) 10V supply: 10.00 ±0.2V

(b) The 5V supply on the Microprocessor and Control Board can be measured on the output pin (pin 3) of IC6. This should be 5.00 ±0.4V

5.3.4 Logic Levels

Malfunctioning of the modem may be due to a fault in the microprocessor or its associated ICs. Usually this type of fault will be accompanied by the failure of the front panel LED to light. (The LED lighting is an indication that the microprocessor and its oscillator are operational.) Whilst it is not possible to read specific data outputs from the microprocessor and the associated components, an oscilloscope connected to the individual lines of the parallel or serial busses will generally display levels rapidly changing from +5V to 0V; particularly when data is being transmitted or received. Any output not reaching the +5V level, or remaining unchanged should be investigated further.
Levels on the output of the RS232 interface should change from -10V to +10V.

5.3.5 Failure To Communicate Terminal to Modem

Provided satisfactory self calibration has been indicated (refer to 5.2.6) the cause of failure to communicate between the terminal and the modem is most likely to be due to faults in either the UART, IC13, or the RS232 input/output device, IC15.

Operation of the oscillator in the UART can be verified by displaying the waveform at pins 9 and 10 of the IC. If the oscillator is not satisfactory the crystal and its associated components should be examined before replacing the IC. If the oscillator is satisfactory display the waveform at IC15 pin 3 while data is entered at the terminal keyboard. RS232 data pulses, i.e. levels varying from -12V to +12V should be seen at this point. If the levels are satisfactory at this point the waveform at IC13 pin 2 should displayed while data is entered. A similar waveform varying from 0 to +5V should be seen.

If the displayed waveforms are satisfactory the receive path is functioning and the transmit path must be tested. This can be done by observing the waveforms as power is switched on at:

(a) IC13 pin 3 (0 to 5V), and

(b) IC15 pin 1 (+10V to -10V).

If these are acceptable and the connections between the modem and the terminal are satisfactory, the Baud rate settings should be verified. (Refer to the Operating Instructions.)

5.3.6 Self Calibration Failure

Failure of the self calibration procedure will generally be accompanied by a displayed message indicating that the modem has failed to self calibrate. Successful self calibration is indicated by the LED on the Microprocessor and Control Board lighting within approximately 5 seconds of the modem being switched on.

To diagnose the cause of a self calibration failure the self calibration signal can be traced by displaying the waveforms at the points in the order shown below. When a satisfactory waveform can be displayed proceed to the next point. If the waveform at any point is not satisfactory inspect the components suggested:

(a) IC12 pin 10 - A 5V square wave at the centre frequency (nominally 1700Hz.) If not satisfactory substitute the tone generator, IC12.

(b) TP1 (FILTER OUT) - Waveform as for (a). If not satisfactory examine the board interconnection (P3), IC5/A and the associated components.

(c) TP7 - A DC level approximately 4.5V. If not satisfactory verify the 1700Hz tone input at IC6 pin 2. If this is present examine the components associated with IC6 and IC9/B and its associated components.

(d) TP2 & TP8 - Switch off the modem and connect one probe to each test point. Set the gain of the TP2 trace to half that of TP8. Zero both traces. When power is applied the level at TP2 should go to approximately 4.5V while the level at TP8 will vary and gradually go to the same level as TP2. While this test is conducted the relay, K1, should be heard to energise at power on and de-energise when the calibration is complete. If the test is satisfactory the self calibration should have been successful. If the test is not satisfactory proceed to (e).

(e) Anode of D1 - 5V pulses. If the modem is switched off and switched on again the width of the pulses should be seen to vary until they settle to a steady width. If the displayed waveform is satisfactory a steady DC level should be seen at the cathode of the diode. If this test is not satisfactory IC6 and its associated components and IC9/A should be examined.

5.3.7 No Reception Or Transmission

If data cannot be received, it should first be established whether transmission can be achieved. If data cannot be received or transmitted (and the power supplies are satisfactory) the most likely cause is a failure of the microprocessor or its associated components. The failure will usually be accompanied by the failure of the front panel indicator to light.

The operation of the microprocessor oscillator can be verified with an oscilloscope at pins 34 and 35 of IC1. If the 11.059MHz cannot be measured at these points a replacement microprocessor should be substituted. If this does not restore the oscillation the crystal and/or its associated components should be substituted.

If the oscillator is satisfactory logic levels on IC1 and its associated components should be observed. (Refer to 5.2.4.)

5.3.8 Transmission But No Reception

If transmission can be achieved but no data can be decoded, the self calibration should be verified, i.e. no calibration failure message has been indicated and the LED on the Microprocessor and Control Board lights within 5 - 10 seconds of switching on. If the self calibration has been successful the fault is most likely to be due to a failure in the audio reception path. The signal can be traced through the reception path by displaying the waveforms at test points in the order shown below. When a satisfactory waveform can be displayed proceed to the next test point. If the waveform at any point is not satisfactory examine the components suggested:

(a) TP4 (AUDIO IN) - Audio tones from the receiver, approximately 1V peak to peak. If not present examine the waveform at P4 pin 6 and the RC filter components.

(b) TP1 (FILTER OUT) - Audio tones from the filter and summing amplifier, approximately 1V peak to peak. If not present examine the waveform at the input to IC5/A (pin 2). If no input at this point examine the filter, IC1 and IC2.

(c) TP7 - Decoded data from the phase locked loop, roughly sinusoidal 100Hz waveform, approximately 1V peak to peak. If not present test for a similar output from the phase locked loop at IC6 pin 11. If present at this point examine the data filter, IC9/B and its associated components. If not present examine the components associated with IC6. If no faulty components replace IC6.

(d) TP9 (DATA IN) - Filtered data, square 100Hz waveform, approximately 5V peak to peak. If not present examine IC8/B, V5 and IC10/A. Note that the collector load for IC5 is in the microprocessor. Any open circuit between the Filter and Demodulator board, e.g. broken ribbon cable or break at P2 pin 7, or a faulty microprocessor may cause the symptoms of an open circuit collector load.

(e) Microprocessor - If the data signal can be traced through to pin 16 of the microprocessor (on the Microprocessor and Control Board) the microprocessor should be substituted.

5.3.9 Reception But no Transmission

If data can be received but not transmitted it is unlikely that the microprocessor is at fault. The tone generator on the Microprocessor and Control Board should be tested first. It should be possible to display the FSK tones at IC12 pin 10. As data is keyed in this output should be a 5V square wave at a frequency changing from 1615 to 1785Hz. If the tones cannot be displayed at this point test for the clock input to IC12 pin 9. (+5V square wave at 5.5MHz.) If this is not present test the operation of IC2. If the clock input is satisfactory replace IC12.

If the output from IC12 is satisfactory the waveform at R20 on the Filter and Demodulator Board should be tested. A waveform similar to that at IC12 should be seen. If the tones are not present at this point the most likely cause is a break in the ribbon cable connecting the Filter and Demodulator and Microprocessor and Control Boards.

If the tones are present at R20 a further test can be made at C30. At this point the waveform will be triangular and approximately 3V peak. If the tones are not present at this point the operation of relay K1 should be examined. Malfunction of the relay may be due to a faulty relay or V2 not conducting. Ensure that the base-emitter junction of V2 is forward biased by the S/ARQ signal. If the S/ARQ signal is not present the interconnections between the circuit boards should be examined but if these are satisfactory the microprocessor must be substituted.

If the tones are present at C30 the PS connector and its cable should be examined.

5.3.10 Failure to Print

If data can be transmitted and received but the printer cannot be operated it should first be established that the printer is serviceable. Most printers have a self-test facility. The manufacturer's instructions should be consulted.

If the printer is serviceable the components of the modem which are confined to the printer operation: latch IC14 and schmitt triggers IC9, should be tested.

(a) Latch - The inputs and outputs of the latch, IC14, can be tested for logic levels. (Refer to 5.2.4.)

(b) Schmitt triggers - The inputs and outputs of the schmitt triggers, IC9 can be tested for logic levels. (Refer to 5.2.4.)

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6 Parts Lists

6.1 General Information

The parts lists for each assembly contain the following information:

(a) Circuit Reference Number.
(b) Description, giving the value and type of component.
(c) Manufacturer and Manufacturer's Part Number.
(d) CODAN Part Number.

Note: Items having numeric references identifying specific components or subassemblies may be encountered in the parts lists included in this manual. These items, selected from master manufacturing information, identify parts which either are useful for maintenance purposes or relate to other items and may be cross referenced in the remarks column.

The following abbreviations are used for resistor and capacitor types.

<u>Resistors</u>

CC - carbon composition
CF - carbon film
MF - metal film
MG - metal glaze
MO - metal oxide
WW - wire wound

<u>Capacitors</u>

AS - solid aluminium electrolytic
CC - ceramic multilayer chip
CE - ceramic
EL - wet aluminium electrolytic
M - stacked mica
PC - polycarbonate
PE - polyester
PP - polypropylene
PS - polystyrene
PT - PTFE
TA - solid tantalum

6.1.1 Ordering Information

When ordering replacement components, all of the following information should be quoted to minimise the risk of obtaining the wrong part and to expedite dispatch.

(a) Equipment type (e.g. Type 7004-A HF Receiver)
(b) Component location (e.g. RF PCB, 08-04685-002
(c) Component circuit reference number (e.g. R47)
(d) Full component description (e.g. Resistor 180kΩ 5% 0,33W CF Res)
(e) Manufacturer and Manufacturer's Part Number (e.g. Philips CR25)
(f) CODAN Part Number (e.g. 40-51800-020)

6.1.2 Component Substitution

Due to continuous process of updating equipment and changes in component availability, minor variations in components may be noted from those listed. Equipment performance is in no way adversely affected by their substitution.

When replacing general purpose components (resistors, capacitors etc.), equivalent parts of other manufacture may be used provided that they have similar tolerances, voltage/power rating and temperature coefficients as those of the specified part.

6.2 Parts Lists Index