

The performance figures quoted 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.

VHF/UHF FFSK MOBILE RADIOTELEPHONE TYPES FM1200/FM1300

SUPPLEMENT TO
FM1000 SERVICE MANUAL

ISSUE 2 JULY 1990

CONTENTS

	Page
SECTION 1 GENERAL INFORMATION	
Summary of Data	1.1
Introduction	1.3
Trunked Mobile Telephone System	1.4
Associated Products	1.4
Equipment Variations	1.5
Glossary	1.6
SECTION 2 INSTALLATION AND OPERATION	
Installation	2.1
Operation	2.1
SECTION 3 TECHNICAL DESCRIPTION	
Circuit Summary	3.1
Control/Digital Signalling PWB	
PWB Non-Prescribed Data	3.10
Standard Console	3.12
SECTION 4 SERVICING	
Precautionary Notes and General Information	4.1
Construction	4.2
Test Equipment	4.3
Test Mode	4.4
Keypad Consoles (FM1200 only)	4.5
Standard Consoles (FM1200 only)	4.6
Keypad Consoles (FM1300 only)	4.7
Standard Consoles (FM1300 only)	4.8
Fault Diagnosis	4.9
Alignment Procedure	4.10
Performance Checks	4.11
Test Data	4.12
SECTION 5 PARTS LIST	
VHF/UHF FM Mobile Radiotelephone Types FM1200 & FM1300	5.1
Standard Console	5.2
SECTION 6 DIAGRAMS	
APPENDIX A FM1200 CUSTOMISATION FUNCTIONS	
Contents	A.1
APPENDIX B FM1300 CUSTOMISATION FUNCTIONS	
Contents	B.1

LIST OF ILLUSTRATIONS

		Page
Fig 1.1	Typical System	1.4
Fig 2.1	Controls and Indicators	2.1
Fig 2.2	Standard Console Display	2.1
Fig 3.1	Power Supply Circuits Block Diagram	3.2
Fig 3.2	Microprocessor Block Diagram	3.3
Fig 3.3	Digital Signalling Block Diagram	3.7
Fig 3.4	FFSK Transmit Timing Diagram	3.8
Fig 3.5	FFSK Receive Timing Diagram	3.9
Fig 3.6	Non-Prescribed Data PWB Block Diagram	3.10
Fig 3.7	Standard Console Block Diagram	3.12
Fig 3.8	Display Driver Timing Diagram	3.13
Fig 4.1	Battery Lead Connector	4.2
Fig 4.2	Location of RV541	4.7
Fig 5.1	Exploded Diagram - Standard Console	5.5
Fig 6.1	Control/Digital Signalling PWB Component Location Diagram	
Fig 6.2	Control/Digital Signalling PWB Circuit Diagram	
Fig 6.3	Non-Prescribed Data PWB Component Location Diagram	
Fig 6.4	Non-Prescribed Data PWB Circuit Diagram	
Fig 6.5	FM1200/FM1300 Standard Console Component Location Diagram	
Fig 6.6	FM1200/FM1300 Standard Console Circuit Diagram	
Fig A.1	Standard Console	A.5
Fig A.2	Keypad Console	A.6
Fig B.1	Standard Console	B.5
Fig B.2	Keypad Console	B.6

FM1200/FM1300 FFSK MOBILE RADIOTELEPHONE - SUPPLEMENTARY INFORMATION

Philips Mobile Radiotelephone Types FM1200 and FM1300 are versions of the FM1000 series VHF/UHF FM radio providing digital signalling facilities for trunking systems. This supplement provides information regarding aspects of the equipments that differ from those described in the FM1000 Service Manual (Publication Reference No TP253) and should be read in conjunction with that publication. Section and side headings are given to facilitate cross-reference.

SECTION 1 INTRODUCTION

SUMMARY OF DATA

FFSK Signalling

Modulation	Fast Frequency Shift Keying (FFSK) logic 1 : 1 cycle of 1200Hz logic 0 : 1,5 cycles of 1800Hz
Bit rate	1200 Bits per second
Encoder frequency tolerance	±100ppm
Environmental condition	-30°C to +60°C

Tone-Signalling (Non-Prescribed Data PWB required)

Address Code Form	Encode only. Five sequential tones.
Tone Frequency Range	810 - 2800Hz (see Table 1.1 for specific frequencies).
Link Establishment Time (LET)	500 milliseconds

TABLE 1.1 - SELCALL TONE FREQUENCIES (FM1300 only)

FUNCTION	CODING CHARACTER	SYSTEM TONE FREQUENCIES				
		CCIR	EEA	ZVEI	DZVEI	ZVEI2
"0" TONE	0	1981	1981	2400	2200	2400
"1" TONE	1	1124	1124	1060	970	1060
"2" TONE	2	1197	1197	1160	1060	1160
"3" TONE	3	1275	1275	1270	1160	1270
"4" TONE	4	1358	1358	1400	1270	1400
"5" TONE	5	1446	1446	1530	1400	1530
"6" TONE	6	1540	1540	1670	1530	1670
"7" TONE	7	1640	1640	1830	1670	1830
"8" TONE	8	1747	1747	2000	1830	2000
"9" TONE	9	1860	1860	2200	2000	2200
GROUP TONE	A	2400	1055	2800	2600	886
EXTENDED TONE	B	930	930	810	1749	—
ALARM TONE	C	2247	2247	970	886	810
SELECTABLE TONE	D	991	991	886	810	—
REPEAT TONE	E	2110	2110	2600	2400	970
TONE LENGTH	(ms)	100	40	70	70	70

Note: All frequencies are in Hz.

Tone sets are NOT standard Philips ST-500 tone sets.

Not all combinations of frequency bands, options etc are available for every market area.



INTRODUCTION

Transceiver Types FM1200 and FM1300 are digital signalling radios designed for use in trunked mobile networks. The equipment differs from the FM1100 analogue transceiver in that it is fitted with a Digital Signalling version (FFSK) of the Control PWB assembly. Apart from operational differences and descriptions of ancillaries normally found only on FM1200 and FM1300 radios, this Service Supplement provides information on the FFSK Control PWB assembly only.

Although all standard FM1000 frequency bands can be supplied, the FM1200 radio is principally used on Band III (174 - 225MHz). It is fully approved to operate on the Band Three Radio Limited public network. These channel trunking systems allocate free channels to subscribers (for mobile-to-mobile or group calls) in real time. On completion of the call, the channel is made available for re-allocation to other subscriber calls.

Call connection and channel allocation is controlled by the base control system. Fast Frequency Shift Keying (FFSK) digital signalling to MPT1327 and MPT1343 specifications is employed.

FM1300 radios are designed for use on systems employing an extended version of the MPT1327 signalling protocol. For example, they allow manual channel selection for simplex or control channel working.

A Non-Prescribed Data PWB can be plugged into the Control PWB, allowing connection of an external MODEM (via a socket on the front of the radio) and generation of sequential tones for revertive paging. No provision is made for the decoding of sequential tones.

An RS232 interface (CCIT standard V24) is available, allowing connection of the radio's external message bus to MODEMs, printers, personal computers etc is available and is detailed in a separate publication.

TRUNKED MOBILE RADIOTELEPHONE SYSTEM

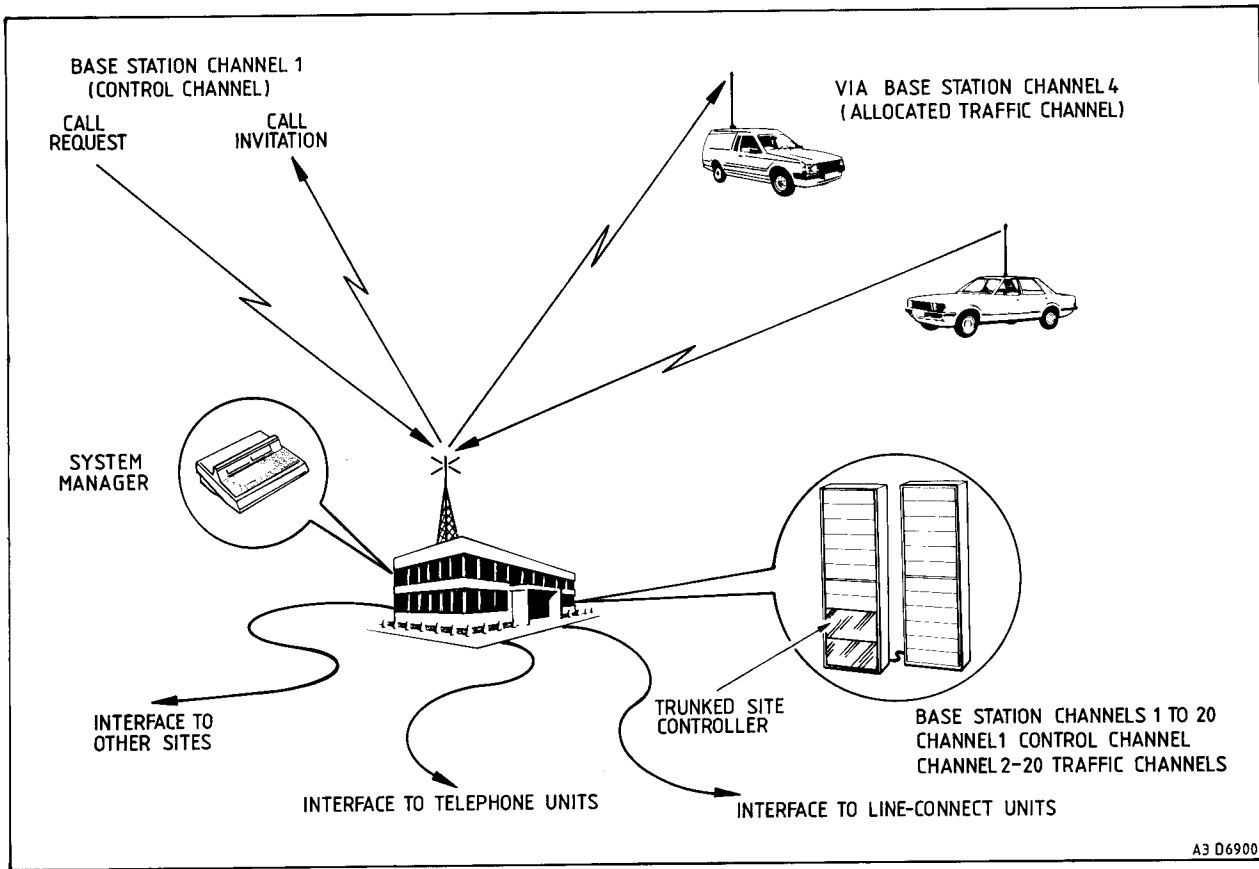


Fig 1.1 Typical System

Summary of Typical Facilities

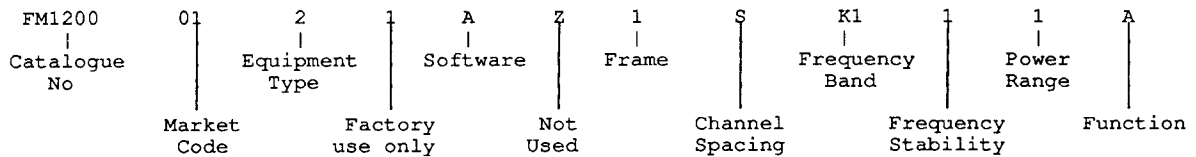
- a. All channels are shared between users.
- b. Traffic channels are allocated on first-come first-served basis.
- c. Mobile to mobile (individual or groups).
Mobile to dispatcher.
- d. Automatic queue facility for calls.

ASSOCIATED PRODUCTS

- | | |
|--------------------------------------|----------------------------------|
| (2) FM1200/FM1300 Keypad Console | (Publication Reference No TP251) |
| (7) External Interface Unit (RS232C) | (Publication Reference No TP874) |

EQUIPMENT VARIATIONS

The sub-assemblies fitted to the transceiver will vary according to the role in which it is used. The complement of sub-assemblies for any particular equipment is indicated by an ordering code number marked on the equipment caseback. A typical order code number is given below, together with a list of codes which are not self-explanatory.



Market Code

- 01 Standard production
- 02 France
- 03 West Germany
- 09 Canada
- 12 Finland
- 19 Malaysia
- 30 Hong Kong

Equipment Type

- 2 FFSK Transceiver Type FM1200
- 3 FFSK Transceiver Type FM1300

Software

- 0 Less EEPROM and EPROM
- A FM1200, Standard Console
- B FM1200, Keypad Console
- C FM1300, Standard Console
- D FM1300, Keypad Console

Frame

- 1 Standard Frame
- 2 Extended Frame (required for Keypad Console and/or External MODEM)

Channel Spacing

- S 12,5kHz
- R 20kHz
- V 25kHz

Frequency Band

- E0 68 - 88MHz
- B0 132 - 156MHz
- A9 146 - 174MHz
- K1 174 - 208MHz
- K2 192 - 225MHz
- TM 400 - 440MHz
- T4 425 - 450MHz
- U0 440 - 470MHz
- W1 470 - 500MHz
- W4 500 - 520MHz

Frequency Stability

- 1 ± 5 ppm
- 2 ± 2 ppm

Power Range

- 1 Standard VHF (1-25/30W)
- 2 Standard UHF (6-25W)
- 3 Low Power UHF (1-6W)

Function

- 0 Less Control/Digital-Signalling PWB
- A FM1200 (FM)
- B FM1200 with Modem Interface (FM)
- C FM1300 (FM)
- D FM1300 with Modem Interface (FM)
- E FM1200 (PM)
- F FM1200 with MODEM Interface (PM)
- G FM1300 (PM)
- H FM1300 with MODEM Interface (PM)

GLOSSARY

Access Codes

Each base station sends access codes which identify the zone and area it is operating within. For a radio to be able to operate with that station, it must be programmed with one or more matching access codes.

Alarm

An emergency call which takes priority over all other calls and which is directed to one of the short-form memories.

CCSC

Control Channel System Codeword.

Comprehensive Hunt (FM1200 only)

When the carrier from a base station drops below a pre-determined signal level, the radio searches specific channels for an alternative base station within the same zone or area through which it can resume communications. If an alternative cannot be found and Comprehensive Hunt is enabled, then the radio searches all channels for any base station with which it is permitted to communicate. If Comprehensive Hunt is not enabled then the radio terminates communication and awaits action from the user.

DTI

Department of Trade and Industry. The radio regulatory body for the United Kingdom.

Emergency number

This is the identity of the station to which calls are directed.

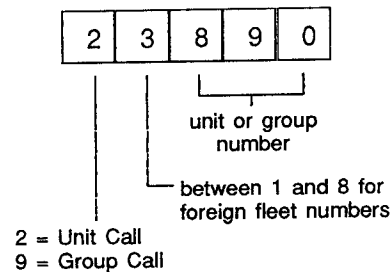
Fall-back channel number

The Fall-back channel is the channel the radio selects when no control channel is available, or when a base station instructs the radio to go to Fall-back mode. When in Fall-back mode the radio is operating as a single-channel simplex radio with signalling functions enabled.

Fleet details for 5-digit codes

This is a form of abbreviated dialling which allows the user to access units and/or groups in other fleets.

5-digit code



The last three digits of the code correspond to the unit or group number of the 'foreign' fleet.

Ident

A 13-bit number used for identification purposes. Ident values of between 1 and 8100 inclusive are assigned to individual units or groups, in which case they are associated with a prefix to form a 20-bit address.

Item warning

If the radio is programmed with transmit timer enabled, the Item warning parameter will issue a warning of impending time-out.

MPT1317

The Code of Practice for the transmission of digital information over land mobile radio systems (DTI April 1985).

MPT1323

Performance requirements for angle-modulated radio transmitters and receivers in the private mobile radio service (DTI October 1986).

MPT1327

Signalling standard specification for land mobile radio systems (DTI January 1988).

MPT1343

The system interface specification for radio units to be used with commercial trunked networks in Band III, sub-band 2 (DTI January 1988).

PABX

Private Access Business Exchange.

Prime despatcher

This is the identity of the station (eg the System Operator) to which priority calls are directed.

PSTN

Public-Switched Telephone Network.

RQC

Short data message request.

RQE

Emergency request.

RQQ

Status request.

RQR

Status request.

RQS

Simple request.

RQT

Call Diversion request.

RQX

Cancel/Abort request.

Single-digit dest(ination)s

This parameter allows you to program dial strings which relate to short-form destination numbers. Note that the dial strings may be used to select functions (such as 're-direct calls') in addition to telephone or user numbers.

Characters 0 - 9, * and # only may be used.

TSC

Trunked Site Controller.

SECTION 2 INSTALLATION & OPERATION

INSTALLATION

For installation information, refer to FM1000 Installation Instructions (Publication Reference No TP858).

OPERATION

Note: For detailed operation, refer to the following User Guides:

FM1200 with Standard Console
FM1200 with Keypad Console
FM1300 with Standard Console
FM1300 with Keypad Console

Publication Ref TP1949
Publication Ref TP1957
Publication Ref TP1991
Publication Ref TP1966

STANDARD CONSOLE

The Standard Console has eight function buttons, an ON/OFF button, a six-digit display, 16 programmable indicators, 10 function-specific indicators and a rotary volume control.

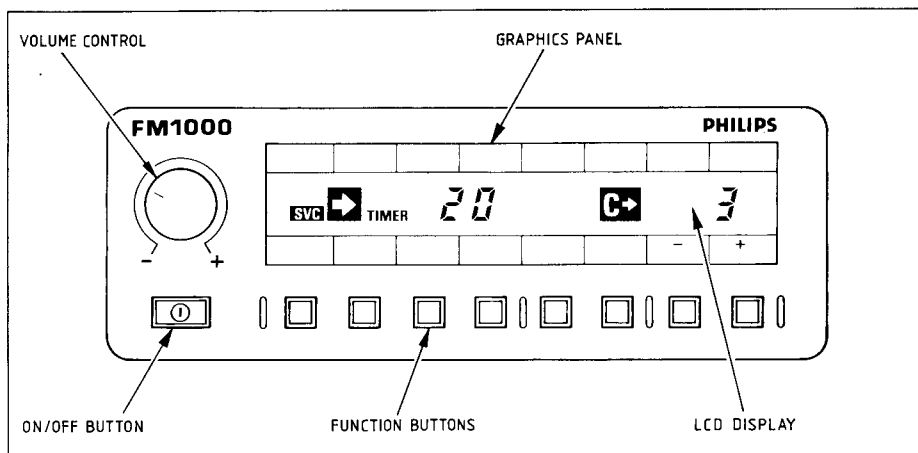


Fig 2.1 Controls and Indicators

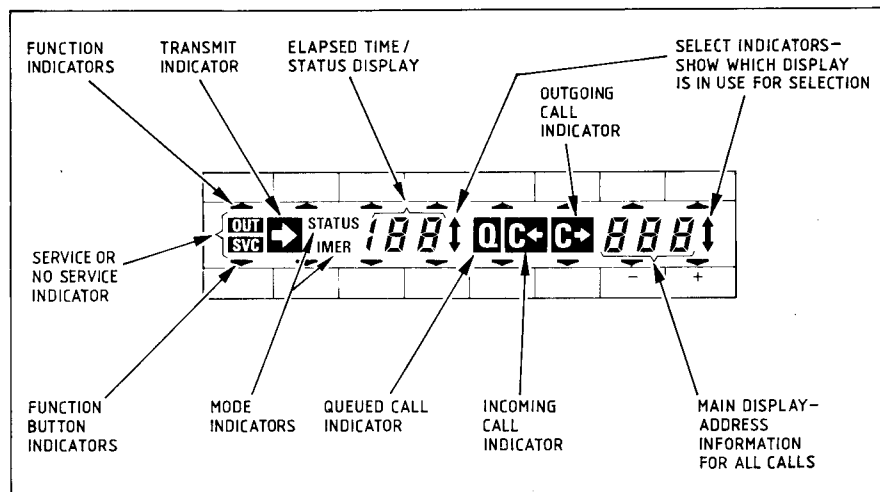


Fig 2.2 Standard Console Display

SUMMARY OF OPERATION

To Switch On

Press the ON/OFF button: The console illumination and display backlighting will light. The radio will enter a self-check routine during which time all display segments will briefly be visible before the radio will display its own unit number. After two seconds, the display will then revert to normal and the radio will be ready for operation.

To Receive a Call

A call is indicated by a double pip-tone (two short beeps), the Incoming Call indicator and the number of the caller.

1. Accept the call by operating the Press-To-Transmit or Call button, or by taking the microphone off-hook. A further tone will sound to indicate that the call may be answered.
2. Answer the call by operating the Press-to-Transmit button or taking the microphone off-hook and speaking.

To Make a Call

1. Select the number you wish to call.
2. Depress the Call button.
3. Wait until the call is set up (indicated by a beep or by the end of the Called Party ringing tone).
4. Remove microphone from the hook switch and make your call by operating the PTT button and speaking.
5. On completion of call replace microphone or press Clear button.

ALERT TONES

Type 1 - Key Click

This is a 1500Hz tone of 50ms duration. This provides a 'Click' every time a key is pressed.

Type 2 - Operator Alert (Buzz)

This is a 400Hz tone of 150ms duration.

Type 3 - Hard Error

This is a 400Hz tone which is on for 150ms and off for 150ms, repeated for 5 seconds.

Type 4 - Number Unobtainable (Unbroken Low Tone)

This is a continuous 400Hz tone which lasts for 5 seconds unless cancelled early (by going on-hook).

Type 5 - Call Fail (Broken Low Tone)

This is a 400Hz tone which is on for 370ms and off for 370ms, repeated for 5 Sec unless cancelled early (by going on-hook).

Type 6 - Call Queued, Transaction Confirmed, Call Clear (Double Pip)

This is a 400Hz tone which is on for 100ms, off for 100ms and on again for 100 mSec.

Type 7 - Call Set-up In Progress (Repeated Double Pip)

Double Pip tones as above but repeated every 6 seconds until a terminating event. This is used for Call Set Up In Progress (Outgoing and Incoming).

Type 8 - Go To Channel (Blip)

This is an 800Hz tone of 370ms duration.

Type 9 - Called Party, Alert (Telephone Ring - UK)

This is a 800Hz tone which is on for 500ms, off for 500ms and on again for 500ms, repeated every 4 seconds until a terminating event (eg call is answered).

Type 10 - Called Party, Alert (Telephone Ring - France)

This is a 800Hz tone which is repeated every 6 seconds until a terminating event (eg call is answered).

SECTION 3 TECHNICAL DESCRIPTION

CIRCUIT SUMMARY

The transceiver consists of five PWB assemblies as in FM1100, but the Control PWB is replaced by the following assembly:-

DIGITAL SIGNALLING	comprising Non-Prescribed Data PWB (optional), main transceiver microprocessor with clock oscillator, EPROM, EEPROM, RAM, Shift Registers, timers, 30V generator and FFSK signalling circuits comprising microprocessor, EPROM, Address Latch, RAM, MODEM and peripheral devices.
--------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

All FM1200 control and signalling functions are provided by the Control/Digital Signalling PWB assembly. This PWB contains two 80C31 microprocessors IC312, IC548. IC312 acts as the main control for the FM1200, and communicates with peripheral devices (eg consoles and data programmers) via a serial bus. The bus is interrogated on a regular basis and the state of the FM1200 altered depending on information received. Control of the analogue part of the radio is achieved via serially driven shift registers, the outputs of which directly control the analogue functions. Certain internal voltages within the FM1200 radio are monitored via an Analogue-to-Digital (A-to-D) converter (IC301) and an input shift register (IC303). Customisation data, such as the frequency band and the key and indicator functions, are held in EEPROM (IC311) to which the microprocessor has access. IC548 controls all 'over the air' signalling via an FFSK MODEM (IC546). It decodes the incoming bit stream from the MODEM to detect valid signalling. Relevant signalling messages are then passed via a dedicated serial bus to the control microprocessor (IC312). Encoding of FFSK for transmission is performed by the signalling microprocessor which outputs binary data to the MODEM which converts it into FFSK audio.

The Non-Prescribed Data PWB allows interface between the radio and an externally-mounted MODEM. Sequential tone information generated by the signalling microprocessor may be processed on this PWB prior to transmission by the radio.

CONTROL/DIGITAL SIGNALLING PWB

Power Supply Circuits

When the FM1200 radio is switched on, unregulated DC is supplied to the Control PWB from the Analogue PWB via SKTB. This is used to supply two single chip voltage regulators which provide outputs of 5V and 8V respectively. The 5V line is used to feed the logic control circuitry and 8V is used to supply the audio circuitry for the FFSK signalling.

The unregulated DC input is also used to supply the 30V generator circuit which is required for the synthesiser loop filter. This is generated by IC318, a charge pump device. Adjustment of the 30V output is achieved by RV301 which senses the rectified and smoothed output of the device and feeds it back to its control pin.

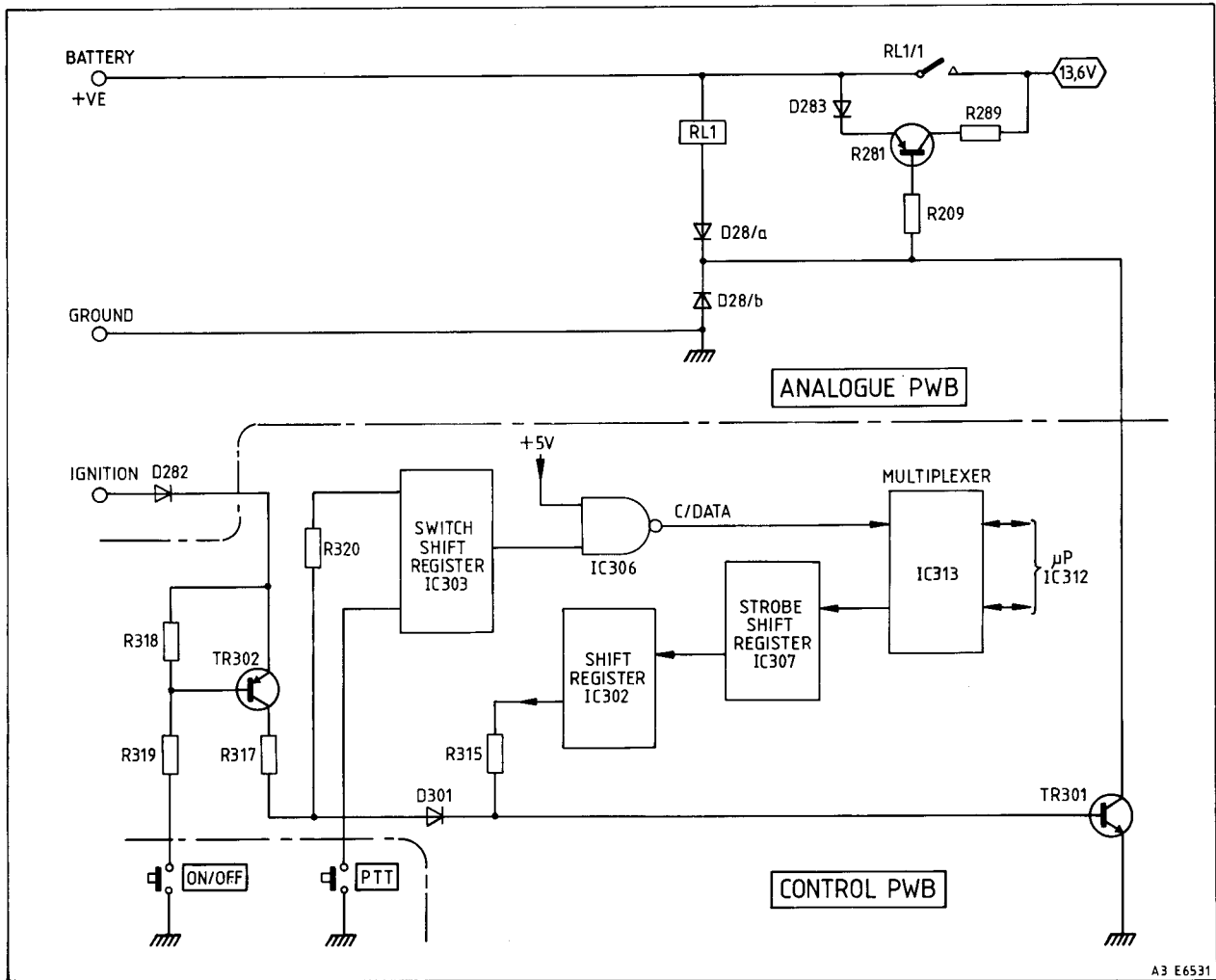


Fig 3.1 Power Supply Circuits Block Diagram

ON/OFF CIRCUIT

DC power from the vehicle battery (or other external PSU) is switched on or off by a relay mounted on the Analogue PWB. To switch the equipment on, the Ignition line must be connected to the external DC supply and the incoming on/off control line grounded (eg: by pressing the console on/off switch or plugging in a data programmer). TR302 effectively forms an AND gate with the ignition and on/off inputs. When the ignition line (TR302 emitter) is high and on/off line (TR302 base resistor) is low, TR302 switches on. This in turn switches on TR301, the collector load of which is the power on/off relay. When this occurs, the control microprocessor can hold the FM1200 radio on by setting Q4 of IC302 high. This feature also enables the data to be saved to EEPROM after detecting switch off. The state of the on/off line is monitored via the D0 input of the switch input register IC303.

CONTROL MICROPROCESSOR

The control processor uses a nominal 12MHz clock frequency. This is provided by TR307, TR306, TR305 and XL301 which form a pullable oscillator circuit. On power up the microprocessor requires to be reset. This is performed by IC314 which applies a positive pulse of approx 20ms at the reset input of the microprocessor when it detects the 5V supply rail ramping up. In normal operation no further reset pulses should be applied.

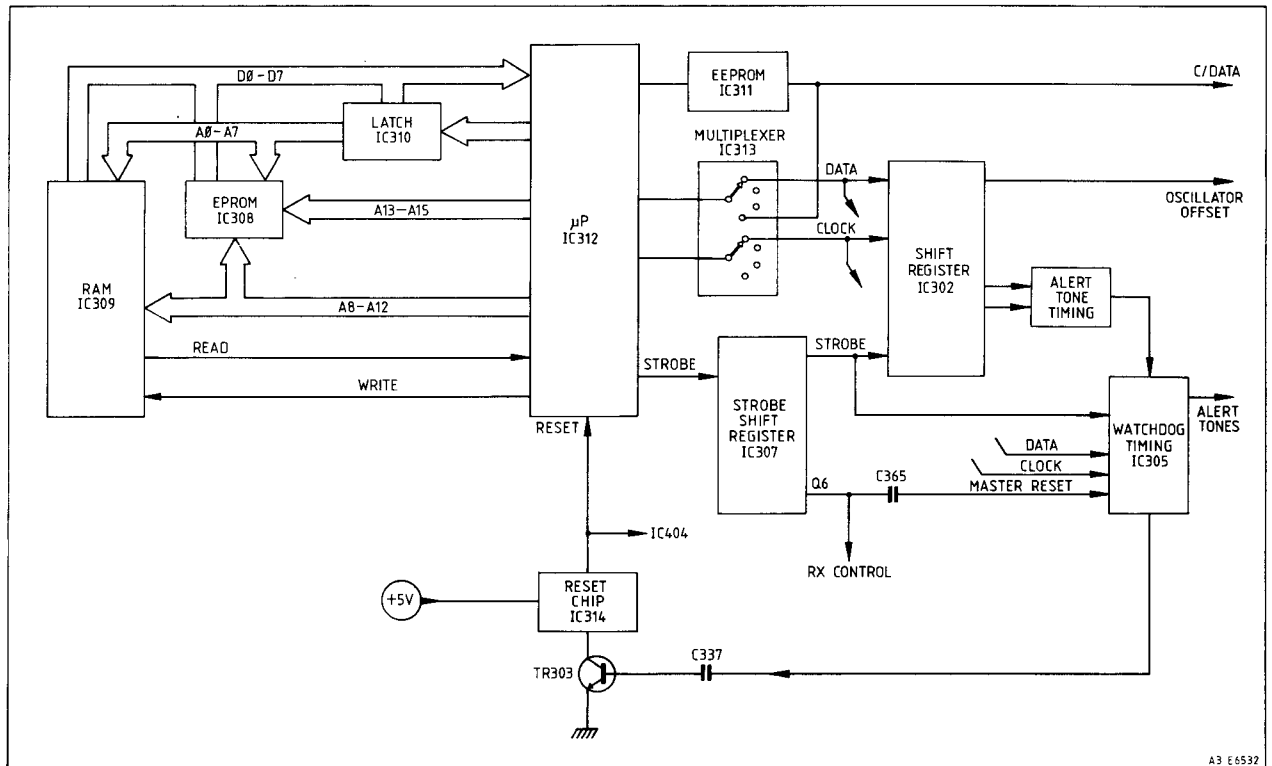


Fig 3.2 Microprocessor Block Diagram

The microprocessor executes software code held in a 64K EPROM (IC308) which it accesses via its external address/data bus D0 to D7 and A8 to A15. The device operates on a 8-bit wide data bus and 16-bit address bus. In order to reduce the pin count of the 80C31, the low order address bus is multiplexed with the data bus. To separate these functions an address latch (IC310) is used. This acts as a transparent latch gated by its LE input. When the microprocessor outputs its low order address it also sends out a positive pulse on its ALE line which gates the low address through to the output of the latch. Also connected to the external bus is an 8k x 8 static RAM (IC309) which also uses the address latch, but control of Read and Write functions is via two separate control lines from the microprocessor, "/RD" and "/WR".

To avoid data corruption during short power interruptions (FM1200 only), the RAM supply voltage is fed via a series diode and reservoir capacitor, which can maintain the contents of the RAM for at least 20 seconds. To avoid corruption at reset the reset pulse is inverted by TR309 which sets CHIP SELECT 'low', disabling the RAM for the duration of the reset pulse.

When first switched on, the microprocessor software will initialize the FM1200 radio by commands sent on the serial bus. Ports 3.1 and 3.0 on IC312 connect to a serial UART held on chip. This can be configured in a number of different ways determined by the radio software. The FM1200 utilizes two of the available UART modes and further sub-divides these depending on whether the bus connects to an external device or devices internal to the radio. A bi-directional multiplexer IC312 is used to connect the serial UART to each bus in turn. Selection is controlled by P1.1 and P1.0 of the microprocessor. The operation of each bus is explained below:

INTERNAL EXPANSION BUS (IEB)

This bus is formed by lines CLK and C/DATA from pins 11 and 4 of the multiplexer IC313. It is used to drive a number of Input and Output shift registers contained on both the Control PWB and the Analogue PWB.

To write to an output shift register (74HC4094), the microprocessor writes data into the shift registers on the C/DATA line. The Clock signal is provided by the CLK line which is connected to all shift registers on this bus. To write to any of the shift registers, it first sends out an 8-bit data byte corresponding to the output pattern it wishes to write to the selected shift register. This data will be stored in the strobe shift register (IC307). This is immediately followed by an address byte for the selected shift register. As the address byte is clocked into the strobe shift register the previous data byte is clocked out of it (on pin 10) and is clocked via the data inputs into all the output shift registers on the bus. By applying a pulse on P1.4, the strobe and output enable of IC307 are momentarily enabled causing the address byte to appear on its parallel outputs. This byte will be chosen so that a '1' is passed to the strobe of the required output register, hence only that shift register will be strobed, latching the required data byte onto its parallel outputs.

To read from the switch input shift register (74HC165), a similar technique is used. Bit Q4 of the strobe shift register is sent momentarily low. This is connected to the shift load input of the Switch Input Register IC303, causing data on its parallel inputs to be loaded into IC303's internal shift register. By applying eight clock pulses on the CLK line the data is serially clocked out from IC303 pin 9 via an open collector NAND gate (IC306) and read in by the microprocessor. To avoid contention when writing to the C/DATA line from the microprocessor, the open collector output of this NAND gate must be set high. This is achieved by sending eight clock pulses to the switch input register (which has its serial input tied to 0V), thus filling the shift register with '0's.

The switch input register is read every 10ms. Output devices on this bus are written to as required.

EXTERNAL EXPANSION BUS (EEB)

This bus operates in an identical manner to the Internal Expansion Bus but uses separate CLK, C/DATA and Strobe lines. It is used to interface with certain ancillaries such as the Keypad Microphone which has internal shift registers in it. Each ancillary also contains a separate strobe shift register which is enabled by a strobe signal from P1.2 of the microprocessor. IC315 is used as a line driver. When writing out on the bus the microprocessor enables this line driver by switching P1.3 low. Taking P1.3 low also sets the output of a NAND gate in IC306 high during writing to avoid bus contention. When P1.3 is set high the microprocessor reads from the bus. Incoming data is buffered by IC315 and passed via IC306 (now enabled) and IC313 to microprocessor IC312.

When first switched on, the microprocessor will read the bus to detect if any ancillary is connected. If so, it will 'poll' the bus every 10ms; otherwise the bus will be ignored until the FM1200 radio is next switched on or is reset.

EXTERNAL MESSAGE BUS (EMB)

In this mode the UART is set up as a 378 kilobit serial link communicating on the TxD and RxD lines on SKTC/PLA. The EMB is used to communicate with complex peripherals such as the Standard Console or the Portable Data Programmer. At switch-on, IC312 sends out a series of pre-defined messages to all the possible peripherals which can be connected to the radio. If connected, the peripheral will respond to the message and IC312 will then send out messages to the device every 10ms. If a peripheral device is not connected at the time of switch on, and hence doesn't reply, IC312 will assume that it is not connected and send no more messages to that device.

INTERNAL MESSAGE BUS (IMB)

This bus is similar to the EMB. However, the signalling microprocessor is the only device connected to it. To ensure fast communication from the signalling microprocessor to the control microprocessor, use is made of the control micro's INT0 input (to avoid having to wait for the control micro to request the transaction).

Analogue-to-Digital (A-to-D) Converter

IC301 is an 8-bit resolution A-to-D converter. It is used for monitoring the state of various voltages from the RF and audio parts of the radio. The following inputs are used:

- 1 Tune Volts: This is used for monitoring the VCO tuning voltage. If it is outside a certain range, it will increment a hardware error count in EEPROM. The radio will, however, remain operational.
- 2 Supply voltage: This is used when monitoring transmitter power to detect whether a reduction in transmitter power was caused by a reduced supply voltage.
- 3 Tx Temp: This is connected to a thermistor circuit held in the transceiver casting. If an excessive temperature is detected, the control unit will reduce the transmitter power by steps until the temperature falls again, or zero power is reached. If zero power is reached, the FM1200 radio will switch back to receive mode.
- 4 Noise Level: This is used to determine the quieting of the receiver and, if appropriate, open the squelch.
- 5 RSSI: This is a DC signal from the IF amplifier, used to determine the signal strength. It is used for squelch control and when hunting for a suitable channel to communicate with the trunked radio network.
- 6 Power Level: This input is from a diode detector circuit on the PA. It is used to monitor the transmit power. If excessive or too little power is detected, the output power is reduced in steps in the same way as with excessive temperature.
- 7 Volume: This input comes from the console volume potentiometer which gives a DC level depending on its setting. The microprocessor sets the digital audio attenuator on the analogue board according to this value.
- 8 Hook/Facility Switch: This is an input from the microphone. These switches are connected with resistors in such a way that the voltage on this pin depends on which combination of switches are closed, and enables their operation to be detected by the microprocessor software.

The A-to-D convertor uses the 5V rail on the Control PWB as a reference. It is driven from the Internal Expansion Bus using a method similar to that employed for the input and output shift registers. To enable a conversion, the microprocessor uses the IEB to inform the device which of the inputs is required to be converted. It then takes P3.5 low to signal that conversion should now take place. The chip uses the ALE line from the microprocessor as its system clock. (On average ALE will run at 2MHz as code is executed from the EPROM.)

Alert Tone Generator/Watchdog Timer

The alert tone generator is a simple RC inverter oscillator made up of C326,R328 to R331 and IC305 which contains on-chip inverters. The alert tone frequency and gating is controlled by IC302. The shift register outputs of IC302 are used to modify the oscillator's RC time constant depending on which alert tone is required, and the Q7 output is used to gate these tones on or off. The resultant audio is mixed with the loudspeaker audio on the Analogue PWB. IC305 also contains a series of cascaded dividers which reduce the RC oscillator frequency down by factors of 2. If allowed to run for long enough, a pulse will appear on the divider output at pin 1, causing TR303 to switch on and the reset chip to send a pulse to reset the microprocessors. In practice, this is prevented by C365, which transmits pulses from the strobe shift register and resets the cascaded dividers within IC305. However, if the software is not running properly, this will not occur, and a reset pulse will be generated.

Microprocessor Oscillator

IC312 is supplied directly from the oscillator output and supplies the signalling microprocessor via an internal buffer from its XTAL2 output. XL301, TR305 and associated components form a standard Colpitts oscillator. Transistors TR306, TR307 are used to switch in a different crystal load capacitance depending on the logic level at Q1 of IC302. The oscillator frequency can thus be offset slightly when a direct harmonic of the crystal falls close to the current receive frequency. Each time the radio tunes to a new channel, the microprocessor calculates whether frequency offset is necessary, or not. When transmitting, the oscillator is always set to its nominal 12,096MHz.

EEPROM

IC311 is a serial EEPROM used for storage of all customisation data. Depending on customer requirements a 512 byte or 2 kilobyte device is fitted (X2404 and X24C16 respectively). Electrical operation with each device is similar. On power up, the FM1200 radio reads customisation data into RAM before normal operation is commenced. The device uses I²C protocol which utilizes a CLK and DATA line to communicate with the microprocessor. When the microprocessor is communicating with this device, it uses the C/DATA line on the IEB to send and receive data, but generates a separate clock output from P1.5.

If any customisation data is modified (eg by a PDP), the microprocessor will save the changes to EEPROM at switch-off. If there are a substantial number of changes to the customisation data, there will be a noticeable delay between switching off at the console and the FM1200 internal relay opening (power down).

External Alert

This circuitry can be used as either an input or an output. In normal operation this is used as an output to switch an external device (eg a car horn) when the mobile is called. In this case, the microprocessor sets p1.6 high to switch on darlington pair TR308/TR304. The Darlington pair connect to the External Alert pin on the external power socket. This output is also sensed by the microprocessor via R324 and the switch input register. At switch-on, P1.6 is set low and hence TR304 collector floats high. If the External Alert pin is taken to 0V before switch-on, the microprocessor detects that it is being used as an input. This mechanism is used to place the FM1200 radio into test mode (see Section 4 of TP253).

