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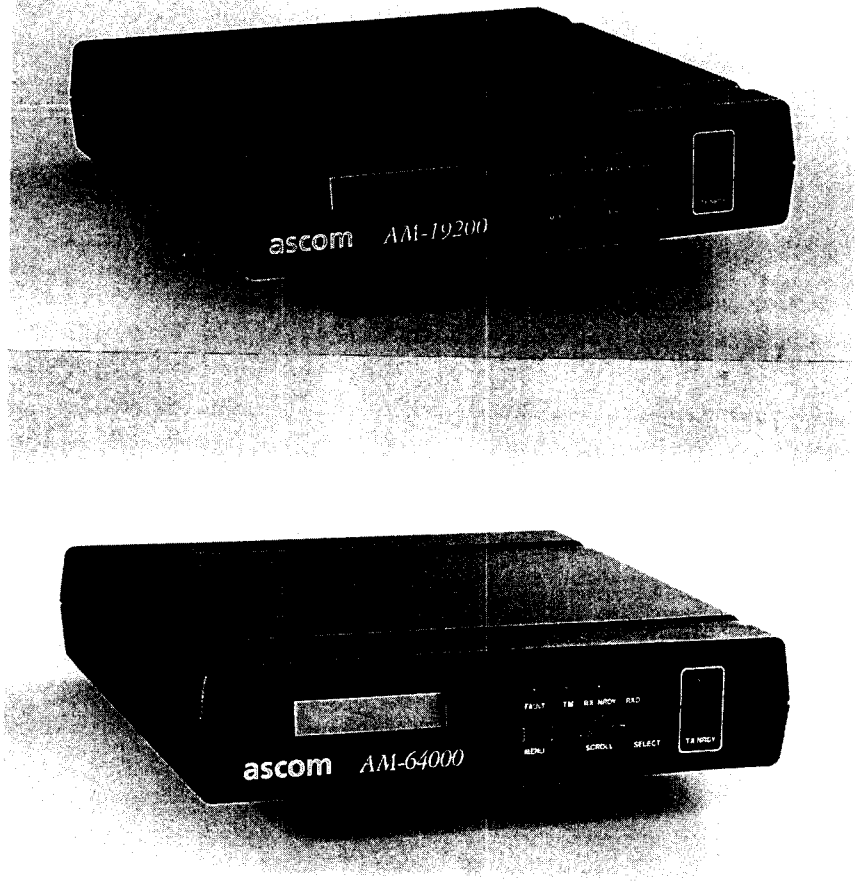
MD9032/9032C.

ascom

Base Band Modems

USER MANUAL

09 OCT 1992



AM-19200A & AM-64000A

BASE BAND MODEMS

USER MANUAL

ASCOM Part No. 1/113/001/610

Contents

1. INTRODUCTION

This manual applies to the AM-19200A and the AM-64000A Base Band Modems (BBM).

The Ascom Telecommunications Ltd. part numbers are:- AM-19200A : 1/113/020/100.

AM-64000A : 1/113/001/100

The unit should have an identifying label carrying this number attached to the underside.

The BBM can provide synchronous communications at user data rates between 2.4kb/sec and 19.2kb/sec (AM19200A) or up to 64kb/sec (AM64000A) over a 2 wire twisted pair cable. Asynchronous communication is also provided at data rates up to 19.2kb/sec.

The BBM can easily be configured using the front panel keys in conjunction with the Liquid Crystal Display (LCD). The display is operated in a menu type fashion with easy to understand mnemonics, which should make constant reference to this handbook unnecessary.

Once configured the operation of the BBM is totally automatic, in the event of line disturbances the data link is immediately restored without operator intervention.

Chapter 4 (installation) describes the basic set up procedure and this should be read prior to setting up any link.

Chapter 5 (menu operation) is much more detailed, but should be read to gain an understanding of the full range of menu facilities available.

The unit is BABT approved for connection to private digital circuits adhering to the X21 or X21bis recommendations (PTO service categories 1 and 2, all rates). Connection of the unit to such circuits is described more fully in appendix F.

The BABT approval number is NS/1284/12/K/601428.

2. CONSTRUCTIONAL DETAILS

2.1 Base Band Modems

The BBM is housed in a black plastic case. On the front panel there is a menu driven LCD display with six keys and five LED's. On the back panel there is a mains power cord, a telephone type line cord, and two D-type sockets. The 15 way socket is for X21 (V11) and the 25 way socket is for X21 bis (V28).
The overall dimensions of the unit are 274L x 251W x 55H mm.
Inside the plastic case is a metal case which contains the main PCB. The metal case is for EMC screening purposes. The front panel assembly containing the LCD, the keys and the LED's is attached to main PCB by two connectors feeding through the metal case. Figure 2.1 shows the BBMs front panels.

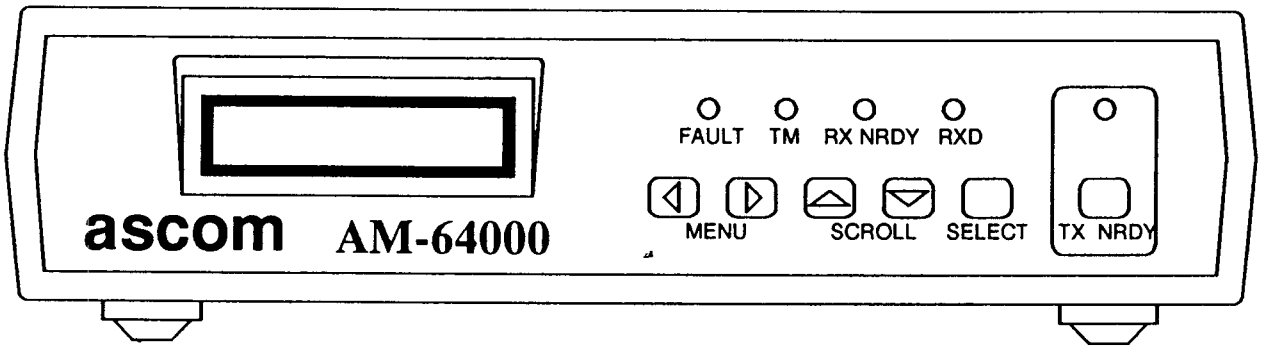


Figure 2.1.A

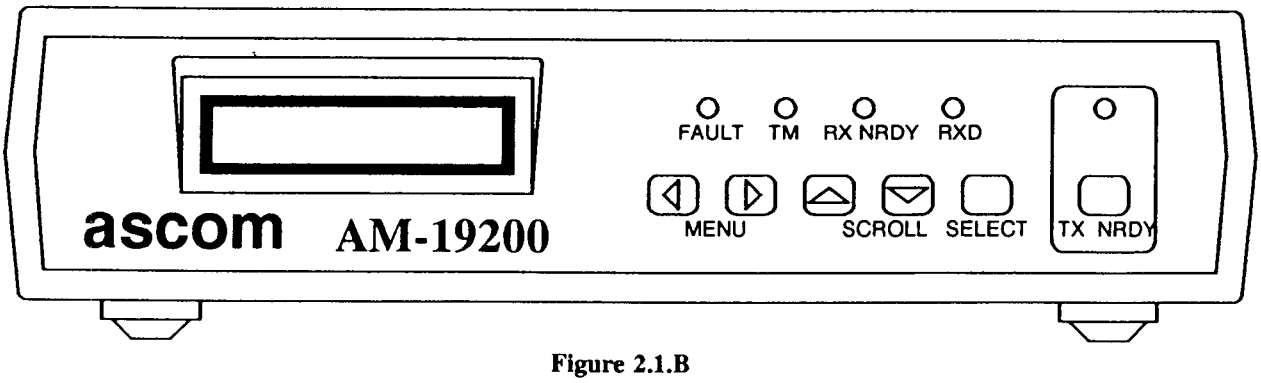


Figure 2.1.B

2.2 V35/V36 Adaptors

To use the V35 or V36 interface an adaptor must be plugged into the back of the BBM. The adaptors are small units in metal cases, (dimensions 121W x 56L x 30H). On the front of the boxes there is a 15 way D-type plug and a 25 way D-type plug which mate with the back panel sockets on the BBM.
On the back of the V35 adaptor there is a 34 way MRAC connector.
On the back of the V36 adaptor there is a 37 way D-type connector.
Figure 2.2 shows the V35 adaptor.

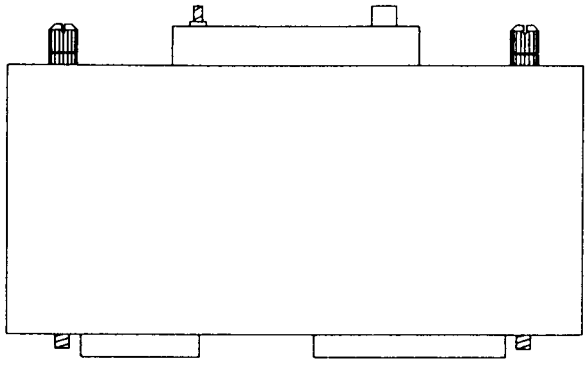


Figure 2.2

3. SYSTEM OVERVIEW

The AM19200A and AM64000A base band modems use the digital transmission system designed and developed by Ascom Telecommunications Ltd. in Cardiff. It is intended for operation on 2-wire local telephone network circuits, such as those meeting BT EPS-9 (2-Wire). It will operate satisfactorily on unloaded lines having a wide range of characteristics; bridge taps can be tolerated, dependent upon their characteristics. Although the system requires a baseband circuit, a continuous loop at DC is not required. The system can transmit data at 71 kb/sec (AM64000A only) or 28 kb/sec; the lower rate is useful in situations where the user rate is less than 19.2 kb/sec and transmission performance is being limited by attenuation or noise.

The line signal comprises AMI-encoded data and an embedded sync pattern which is used for timing control the data consists of user data and a control channel for the systems own use. Echo cancellation is used to eliminate the unwanted reflections of the transmitted signal from the receiver input. The echo canceller can eliminate echoes of up to 16 bit periods duration. To counteract the signal distortion inherent in long lines the system employs adaptive decision feedback equalisation to eliminate trailing intersymbol interference; this also has a span of 16 bit periods. A fixed linear equaliser is incorporated to control the received pulse waveform and to reduce the effect of the long tails of both echo and transmission responses. Digital signal processing is used throughout to achieve high performance reproducibly.
A block diagram of the unit is shown in figure 3.1.

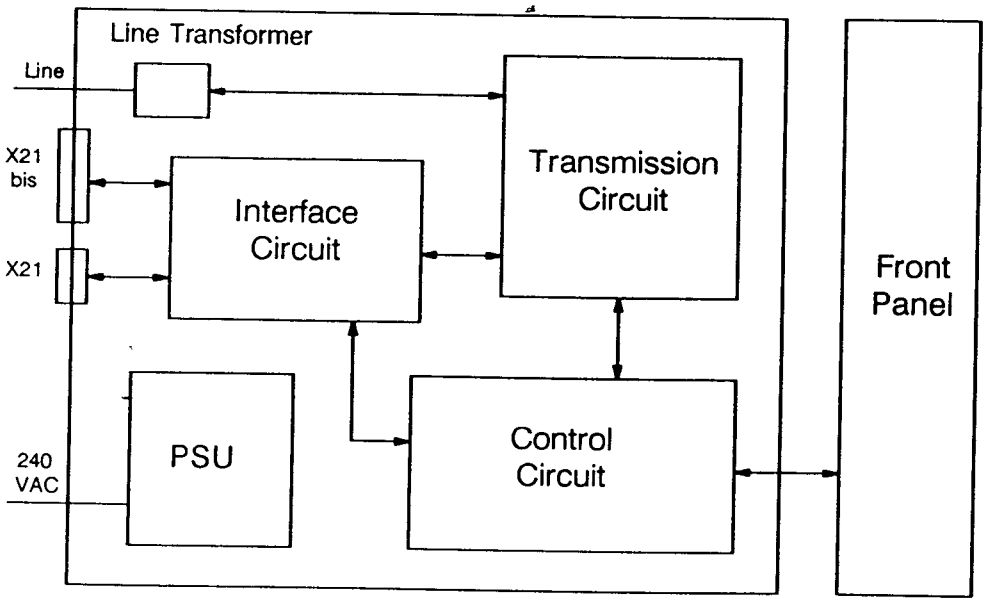


Figure 3.1

The line is connected to the transmission circuit via a line transformer which acts as a balun and provides isolation ; there is surge protection at both sides of the transformer. The transmission circuit utilises a custom IC and a number of proprietary components to perform the signal processing described above.

The interface circuit performs a number of functions: it converts between the user data from the appropriate interface and the 64 kb/sec (AM64000A only) or 25.6 kb/sec, which is transmitted down the line; it links the control circuit to the control channel; it interfaces the control circuit to the control lines of the data ports. Again, these functions are performed by a custom IC supported by a number of standard components. Looking at each function in turn, user data at 64 kb/sec is sent as-is; byte-timing is maintained by the transmission system and is available if required. Data at 56 kb/sec is sent in a 7 + 1 format, i.e. data plus status information. At all lower rates the data is transmitted as octets comprising 6 data bits, 1 framing bit and 1 status bit. At rates below 48 kb/sec the octets are iterated as appropriate to fill the transmission channel.

Turning to the control channel, this uses 4 bits from each transmission frame to transmit control information to the unit at the other end of the line, e.g. user data rate selection, and to monitor the overall performance of the link.

With regard to the remaining function of the interface circuit, the control lines of the data ports mainly require buffering; however, in the case of X21 the various control patterns have to be generated or detected. The control circuit is based on a microcontroller and determines the state of the unit according to the state of the transmission system, the state of the data interface and the configuration information received from the front panel and from the control channel. It also provides the front panel display with information on the current state of the unit which can be reviewed via a simple menu structure.

4. INSTALLATION

This chapter describes the basic steps that are required to set up a system involving the Base Band Modems (BBM's). There are two basic systems that will be considered:

(1) BBM connected to BBM
(2) BBM connected to Line Card

When considering the installation general pointers to the configuration of the BBM's are given. It should be noted that there are many BBM parameters which may be set differently and prevent the results from being as expected. If any results are not as discussed then chapter 5 on menu operation should be consulted.
If this still fails to resolve the problem then the internal links can be checked, see appendix B.

4.1 BBM to BBM Link

With no DTE or line connected to the BBM, plug the mains cord into the 240V supply.
On power up the following messages will be displayed:

Testing	for 2 seconds, all LEDs will be on
Self Test Pass	for 2 seconds, all LEDs will be on
* STATUS MENU *	for 3 seconds, all LEDs reflect status
S >LTU Not Ready	Fault LED lit, (Assuming no line connection at this point)

If the self test fails an error message will be displayed. These are explained in section 5.4.8

The mnemonic LTU stands for Line Terminating Unit, and this should be understood (in all cases) to be the Base Band Modem itself.

For a point to point link to work, one BBM must be set to *master mode*, and the other BBM to *slave mode* (section 5.7.1). If the link is self contained, ie. there is a DTE at both ends and no other links are involved then it makes little difference which end is which. If another link is driven then the master modem must be connected to the external modem, (see section 5.7.3.).

Set the *line rate* (section 5.7.2) to the required setting at both ends, and set the *user data rate* up on the master (section 5.5).

When the line is connected the FAULT LED should now go out.

The interface details should now be configured at both ends. This is done using the *option menu* (section 5.6)
If asynchronous working is required then the internal links will need to be set up. (Appendix B).

The status menu should then be examined to check that the unit is correctly configured.

The following data is provided by this menu:

(a) Overall status (i.e. whether ready or not)
(b) Alarm messages
(c) User data rate
(d) Line rate (not available on AM-19200A)
(e) Interface status
(f) Interface mode

To examine this data, first locate the status menu by using the left arrow key, then use the up/down arrows to look at each item in turn.

With no DTE (Data Terminal Equipment) connected the results should be:

(a) `S> LTU Ready` or `S> LTU Not Ready` (Depends upon interface details)

(b) `S> No Alarm`

(c) Data rate as required

(d) Line rate as required (AM-64000A only)

(e) Interface status as required (usually all lines off, but depends on any X21bis options set)

(f) `S> Link Mode`

If the status is not correct the BBM must be reconfigured. (See section 5 on menu operation.)
If the status is correct the DTE (Data Terminal Equipment) or a data tester may now be plugged into the BBM. In order for end to end data transfer to take place there must be *no test loops active* either locally or remotely. (The power up default for the Test Menu is no loops).

4.2 BBM to Line Card Link

Power up the BBM as described above and set the modem to slave mode.
Set the line rate as required, and connect the line cord.

Consult the line card handbook to set up the user data rate. The modem should then automatically program to this rate.

There should be an *options enable* switch/command on the line card to allow the interface details to be set either from the line card or from the modem. If the interface is to be set from the line card then the enable switch/command should be off and the line card options set as required, (see line card handbook). If the interface is to be set from the modem, then the enable switch/command should be on, and the option menu used as in the above case.

The status menu can then be examined and the DTE connected as with the BBM - BBM case. The displays should be the same, except for the interface mode display (f) which should read:

(f) `S> Network Mode`

4.3 V35/V36 Adaptor Installation

The interface adaptors plug into both the X21 and X21bis connectors on the back panel of the BBM. They are held in place by two locking screws.

The V35 adaptor houses a European type MRAC connector, and the V36 adaptor houses a 37 way D-type connector.

The V35/V36 interface is selected from the *option* menu, (See section 5.6).

Pin outs of both types of connector are given in appendix A.

5. MENU OPERATION

5.1 Front Panel Features

The Base Band Modem has an uncluttered and easy to understand front panel. It has a liquid crystal display, 5 LEDs, and 6 non-locking keys.
With the 16 character alpha-numeric, dot-matrix liquid crystal display it is possible to describe most of the functions in plain English, thus avoiding having to use complicated mnemonics and the need to constantly refer to a handbook.

The 6 front panel keys are as follows:

(1,2)	MENU (left and right)	Used to change menus
(3,4)	SCROLL (up and down)	Used to scroll through items within a menu
(5)	SELECT	Used to activate/deactivate the feature displayed
(6)	TX NRDY	Used to send a Not Ready pattern to line

This pattern is termed Controlled Not Ready (CNR) and consists of alternate 1's and 0's with the status line OFF. (Note that the pattern will not be sent if there is a loopback in operation.)

The LCD display is complemented by the use of 5 LEDs to monitor the following :-

(1) FAULT Red LED
This is lit to indicate the line signal is faulty; the main causes of this are as follows:
(1) No signal received (ie. line broken / disconnected)
(2) Incorrect line rate
(3) Incorrect user data rate
Further information is provided in the *status menu*, (see section 5.3.2).

(2) TM, (Test Mode) Red LED
This is illuminated whenever a test mode is active, (ie a pattern is being generated, or a loop is being applied).

(3) RX NRDY, (Not Ready received from line) Yellow LED
This lights whenever a Not Ready pattern is being received (UNR or CNR), AND a structured user rate is in use, (a rate which has a status line)

(4) RXD, (Received Data) Yellow LED
This indicates the state of the user data, it is turned on for a '1' and turned off for a '0'.

(5) TX NRDY, (Transmitting Not Ready) Yellow LED
This is provided to display the state of the TX NRDY key. Lit means the TX NRDY key is on.

5.2 Front panel operation

The LCD will display one of five menus at any one time, these menus are:

1.	STATUS	(Prompt is S>)
2.	TEST	(Prompt is T>)
3.	RATE	(Prompt is R>)
4.	OPTION	(Prompt is O>)
5.	CONFIG	(Prompt is C>)

In normal circumstances, the front panel LCD will display a *Status* message relating to the overall state of the data link. eg. READY. Additional status information may be displayed by scrolling down through the menu. The *Status* menu is *read- only*. To select the next menu in the list the 'RIGHT MENU' button must be pressed. To go back to a previous menu the 'LEFT MENU' button must be pressed. A prompt on the left hand side of the display will indicate which menu has been selected. On entering a menu its title will be displayed in full before the display reverts to the first menu item and the relevant prompt.

If the equipment is left in a display other than *Status* for greater than one minute the display will automatically time out and revert to the top line of the status menu. If left in the Status menu but not on the top line, the display will automatically time out and revert to the top line of the status menu after 5 mins.

The sequencing through the menus is as follows:

```
* STATUS MENU *
```

```
** TEST MENU **
```

```
** RATE MENU **
```

```
* OPTION MENU *
```

```
* CONFIG MENU *
```

When scrolling through the menus, the items will appear in the order detailed in the individual menu descriptions.

Each menu item display should indicate the current state of that item. For example if the loopback feature was currently inactive then the display should read:

```
T> Loopback Off
```

To change the state of a menu item the 'SELECT' button should be pressed.
The display should then change to reflect the modified status, in the example above the display should change to read:

```
T> Loopback On
```

If a menu item is not appropriate for a given situation then it will disappear from the menu. For example it is not permissible to have a loopback on and binary keys active at the same time. The first one selected will therefore cause the other to disappear from the menu.

Any item selected in the Rate, Option, or Configuration menus is automatically stored in non-volatile EEPROM. These features will thus be restored when the BBM is next powered up.
Items in the Test Menu are not stored and are lost on power off.

5.3 Status Menu

The status menu is read only, which means the select button has no effect. It provides the following data:

(1) Overall status
(2) Alarm messages
(3) User data rate
(4) Line rate (not available on AM-19200A)
(5) Interface status
(6) Interface mode

5.3.1 Overall status

The possible messages for this item are as follows:

S > Loop Active

S > LTU Not Ready

S > LTU Ready

S > Data Transfer

S > Send Data

S > Receive Data

The basic principle of operation of this display is as follows (in priority order):

(a) If a loop is applied within the BBM the display reads | S > Loop Active |

(b) If a fault exists or a not ready signal (including AIS) is being received from line then the display reads:

S > LTU Not Ready

(c) If the status from line (I or 109) is on while the DTE status (C or 105/108) is off then the display is:

S > Receive Data

(d) If the status from the DTE is on and the status received from line is off, then the display is:

S > Send Data

(e) If both status lines are off then the display reads | S > LTU Ready |

(f) If both status lines are on then the display is: | S > Data Transfer |

(g) If the user rate has no relevant status line (rates 16K, 32K, 64K or X50), then the messages c,d, and f are displayed as message e.

5.3.2 Alarm Status

The possible messages for this item are:

S > No Alarm

S > No Signal

S > Receiving AIS

S > No Alignment

The | S > No Signal | display indicates that the transmission system cannot find any signal to lock onto.

Possible causes are:

(a) Broken or defective line
(b) Both ends master, or both ends slave
(c) Incorrect line rate
(d) Line attenuation / noise level too high

The | S > Receiving AIS | display indicates that the AIS (Alarm Indication Signal) pattern is being received from the line. This should not normally occur in a BBM to BBM link. (It can be generated however, if the master BBM is in 64k mode (AM64000A only) whilst sending binary 1's).

The | S > No Alignment | display indicates that the modem cannot lock onto the envelope alignment pattern being received from line.

Possible causes are:

(a) line attenuation / noise level too high
(b) Incorrect set up of X50 modes (AM64000A only)

If none of these modes apply then the message is | S > No Alarm. |

5.3.3 User Rate

This item displays the user rate in current use.

For example | S > 48K 10 |

(A complete list of rates is given in the rate menu)

5.3.4 Line Rate (AM64000A only)

This item displays the line rate in use:

If the high line rate (71.1K bits/sec) is selected then the display is: `S > High Rate`

If the low line rate (28.4K bits/sec) is selected then the display is: `S > Low Rate`

5.3.5 Interface status

This item displays the state of the lines on the DTE interface. For X21 the following messages are included: (Note individual lines can be On or Off dependent on the interface)

`S> C On I On` `S> C Off I Off`

For X21 bis the following messages are included:

`Line 105 on`	`Line 105 off`
`Line 106 on`	`Line 106 off`
`Line 107 on`	`Line 107 off`
`Line 108 on`	`Line 108 off`
`Line 109 on`	`Line 109 off`
`Line 140 on`	`Line 140 off`
`Line 141 on`	`Line 141 off`
`Line 142 on`	`Line 142 off`

There is also a X21 bis composite display with the lines ON displayed as solid blocks.

5.3.6 Mode Display

The BBM is capable of operating in two basic modes:

1. `S> Link Mode` 2. `S> Network Mode`

For a BBM to BBM link this display should read Link Mode. If however a Line Card is used instead of a master BBM, then the display should read Network Mode. The essential differences of Network mode are as follows:

(1) The line card can down line load the Options. (The options X21, X21bis, 105 Set On, 106 Delay, 107 = 108, 108/1 Set On, can be set from the line card and control from the BBM can be disabled)

(2) V35 mode can operate automatically in X21bis at user rates of 48k and above (AM64000A only).

5.4 Test Menu

The Test Menu can be read and written to at all times. The items are not saved on power down, therefore on power up the various tests always default to the off state. The items in this menu are as follows:

1. Local loop
2. Loopback
3. Remote loop
4. Binary pattern
5. Data error test
6. In service error test
7. Lamp test
8. Self Test
9. Comms channel loop

5.4.1 Local loop

The local loop facility is a loop applied within the local BBM. It loops data back to the DTE from a point as close to the interface connector as is possible. This loop can be applied in two ways

(1) From the Menu
(2) Direct from the DTE.

5.4.1.1 Local loop from menu

This is implemented by selecting the item `T> Loc Loop Off`

On pressing SELECT the display should change to `T> Loc Loop On` and the loop should be applied.

The top display in the status menu will display *Loop Active* and the TM LED should also light up.
The data flow with the loop applied is shown in fig 5.4.1.1.

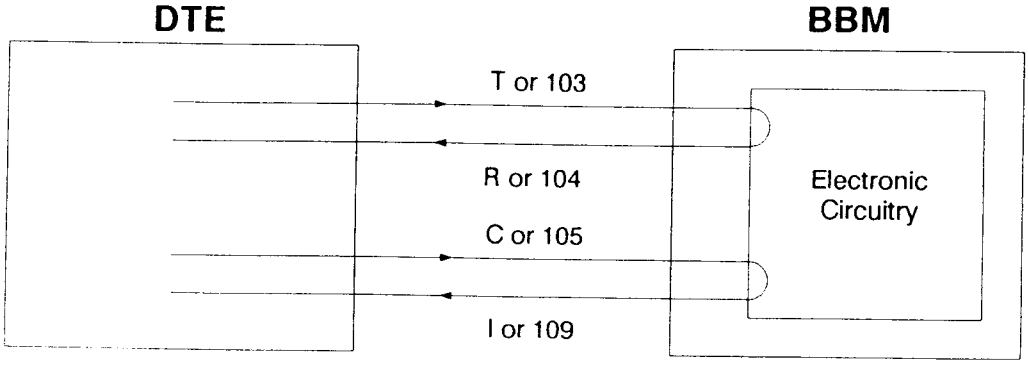


Figure 5.4.1.1

5.4.1.2 Local loop from DTE

When the BBM receives an ALT pattern (11110000) from the DTE, (in X21),or circuit 141 is active, (X21bis) the local loop is applied similarly to the above.
To apply a local loop in this fashion refer to your DTE equipment handbook for details on how to send the pattern.
The BBM can be in any menu when this loop is applied, it does not have to be in the Test Menu.
Note that the Test Menu *Loc Loop* message does not reflect the state of a loop applied from the DTE, but the status menu display and the TM LED will be set as in the above case.
The data flow with the loop applied is shown (as with menu activated loop) in fig 5.4.1.1.
It is possible to have a BBM Menu selected local loop operational at the same time as a DTE local loop. The actual local loop would then only be removed when both the Menu item has been deselected and the DTE has cancelled its loop, (ie the loop is removed by the last releasing action).

5.4.2. Loopback

The loopback feature places a loop on the local BBM in the opposite sense to the local loop, ie the data coming from line is looped back. The DTE is effectively cut off and receives only a Not Ready signal.

The loopback is applied by selecting the item **T> Loopback Off**

Pressing SELECT should cause the display to change to **T> Loopback On**

The loop should then be applied. The TM LED should light and the top level status display should show *Loop Active.*
The data flow for this loop is shown in fig 5.4.2.

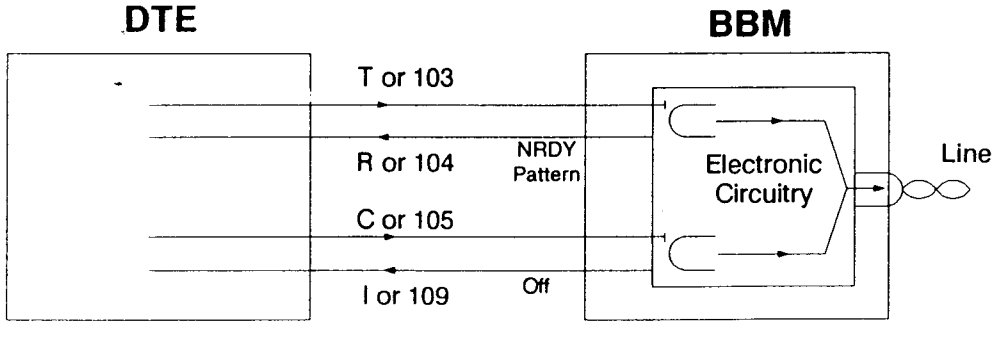


Figure 5.4.2

This loop cannot be activated from the local DTE, only by the remote DTE, and in this case it is termed a *Remote Loop*, (see section 5.4.3).

5.4.3. Remote loop

The remote loop feature involves the turning on of a BBM loopback, but from the other end of the link. This is shown diagrammatically in figure 5.4.3.

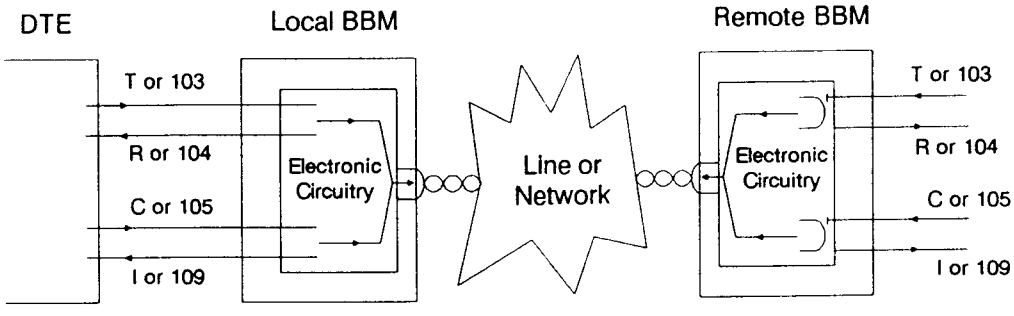


Figure 5.4.3

This feature is only available from the menu if the activating BBM is in X21bis mode. It is available from the DTE in either X21 or X21bis.

5.4.3.1 Remote Loop from menu

The loop should be applied, the TM LED should light and the top level status display should show *Loop Active*.

To apply the loop select the item | T> Rem Loop Off |

Press SELECT and the display should change to | T> Rem Loop On |

Note: as this feature applies a loop at the remote end it is possible that in some circumstances (mainly fault conditions) that the actual loop can be removed without the local BBM realising it. In these cases the display will show *Rem Loop On* when in fact no loop exists. If the loop has been cleared by a transient fault condition it can of course be re-applied by deselecting the Remote loop and then reselecting it. The data flow with the loop applied is shown in figure 5.4.3.

5.4.3.2 Remote loop from DTE

When the BBM receives an ART pattern (00110011) from the DTE (in X21), or when circuit 140 is active (in X21bis) the loopback is applied on the remote BBM similarly to the above. To apply a remote loop in this fashion refer to your DTE handbook for details.

The BBM can be in any menu when this loop is applied, it does not have to be in the Test Menu.

Note that the Test Menu *Rem Loop* message does not reflect the state of a loop applied from the DTE, but the status menu display and the TM LED will be set as in the above case.

The data flow with the loop applied is shown in figure 5.4.3.

It is possible to have a BBM menu selected remote loop operational at the same time as a DTE remote loop. The actual loop would then only be removed when both the menu item has been deselected and the DTE has cancelled its loop, (ie the loop is removed by the last releasing action).

5.4.4 Binary patterns

It is possible to transmit three different patterns to the remote BBM:

(1) All 1's with status ON
(2) All 0's with status ON
(3) Alternate 1's and 0's with status OFF (Controlled Not Ready's or CNR's)

The CNR pattern is sent by pressing the separate TX NRDY key on the front panel. The other patterns are accessed from the binary feature in the test menu.

The default state is sending no patterns when the display is

T> Bin Keys Off

If the SELECT key is pressed then binary 0's are sent and the display should change to

T> Sending Bin 0

If the SELECT key is pressed again then the binary 1 pattern is sent.

T> Sending Bin 1

A third press of select will return the function to its default (off) state.

It should be noted that several factors may prevent the binary pattern being transmitted. The test menu display shows only that a binary pattern will be transmitted *if the BBM is capable of it*. Factors preventing transmission are:

(1) Fault conditions
(2) Loopback active
(3) Local loop active
(4) TX NRDY key active

With most rates the patterns are sent with status ON. If an unstructured rate is used, such as 64k, there is no status line. In this case binary 1's become effectively an AIS signal, and binary 0's become a UNR signal.

5.4.5 Data test

5.4.5.1 Overview

This mode allows the user to send a binary 0's pattern to the far end BBM, and monitor the received data stream for errors. The number of bits received in error is shown on the LCD display.
The time that the test has been running can also be displayed, and this allows the user to calculate the effective Bit Error Rate if so required. This is given by:

$$\text{Bit Error Rate (BER)} = \frac{\text{Error count}}{\text{User data rate} \times \text{Time}}$$

A loop must obviously exist somewhere in the line system for the test to be valid, (unless the far end BBM is also sending a binary 0's pattern and a single direction test is required).

This loop can be applied by the local BBM in one of three ways:

1. Remote loop selected from the Test Menu
2. Remote loop selected from the DTE
3. Comms channel loop selected from the Test Menu. (See section 5.4.9)

Loop (3) is usually most convenient. These loops MUST be applied before the *Data Test* mode is entered.
The loop can of course be applied directly at the far end BBM. This can be done by selecting a Loopback from its test menu.

In order to ascertain from the local BBM whether or not a loop has been applied the *Data Test* has the facility to send a binary 1's pattern. This should result in every bit returned around the loop being in error. So to verify the loop the following procedure can be adopted:

1. Send 0's around loop -If loop present then RXD LED will be off with a low error count
2. Send 1's around loop -If loop present then RXD LED will be on with a high error count (BER = 1)

A further option provided is the facility to allow a data tester to inject the binary 0's pattern. This is to allow use of the extra facilities provided by the tester, (eg injecting single errors), and / or simultaneous error testing of the X21 / X21bis link.

5.4.5.2 Operation

Note: Apply any loops required before entering Data Test Mode.

The display within the test menu is `T> Data Test`

To enter the mode find this entry in the test menu and press SELECT.
There are four displays within this *Data Test* sub-mode:

1. Error display
2. Pattern display
3. Transparency display
4. Time display

Once the mode is entered these displays can be changed by using the scroll keys in exactly the same fashion as in the main menus.
The mode can be exited at any point by a press on one of the MENU keys. This will then bring you back to the line *Data Test* in the test menu.

1/ Error display

The BBM starts to inject a binary 0 pattern immediately the mode is entered. The TM LED should light to verify this.

The display should then be `Errors nnnnnn`

Where nnnnnn is the number of bits received in error. (If the line is error free then the display should remain at 000000.)

The SELECT key now performs two functions:

1. On the first press it will hold the current error count and time, (and stop counting further errors).
A small "s" is displayed just prior to the error count to show this.

For example | Errors s000001 |

2. On the second press the error count and time will be reset, and the test restarted.
If the error count overflows the display will indicate a " > " character just before the error count.

For example | Errors >000001 |

Note that once the error count has overflowed no confidence should be held in the number displayed. (It does not simply wrap around at 999999).

2/ Pattern display

(2) The pattern display usually shows: | Injecting 0s |

If binary 1's are required (for loop verification) press select on this display. Binary 1's will now be injected and the display should change to

| Injecting 1s |

This pattern will continue to be injected until the select key is pressed on this item again, (or the mode is exited)

3/ Transparency display

The Transparency option is usually disabled, when the display reads: | Injection Mode |

If the SELECT key is pressed on this option then the display should change to | Transparent Mode |

The binary 0 injection is then disabled and the data path is direct to the DTE or data tester.

If Transparent mode is now selected the pattern display will show | No Injection |

The facility to inject binary 1's remains, however, and the SELECT key will now toggle between no pattern injected and injecting binary 1's.

4/ Time display

The time display simply shows the time since the test has started in seconds.

For example | Time 000010 | If the count is stopped the display is | T Stop 000010 |

5.4.6 In Service Test

5.4.6.1 Overview

This mode allows the user to monitor the error performance of the line whilst allowing data traffic to continue unhindered. The feature works by monitoring the accuracy of some of the overhead bits that make up the transmission frame structure. As the data channel itself is not monitored the figures produced from this mode cannot accurately be extrapolated to give the data error rate, they should be used as a general guide only.
In order to understand how this feature works a certain amount of knowledge about the transmission frame structure is required. This is included as appendix D. A brief discussion on the operation is given here.

5.4.6.2 Operation

The display to select in the test menu is `T> In Svc Test`

No processes are activated upon entering this mode, it is a monitoring facility only. The mode can be exited and re-entered with no effect on any other tests or data.

There are four different displays within this mode:

(1) Comms framing error display
(2) Received envelope errors
(3) Transmitted envelope errors (master only)
(4) Time of test

The SELECT and SCROLL keys operates in the same manner as in the *Data Test.*

As this mode may be left running over a long period, an *abort* indication has been added to the displays. The character *a* is displayed prior to the count if the test has been aborted. The monitoring is aborted when the system error rates get so high that the envelope alignment pattern / comms framing word cannot be locked on to, or when the system loses line sync. (The error count would be meaningless if the line had been broken in the middle of a test). Note that the different displays may abort at different times, but the clock will stop when the first abort occurs.

The error count displays appear as follows:

(1) `Comms 000000` Comms word error count This is 1/108 Data error count

(2) `Evp Rx 000000` Received envelope errors This is 1/6 Data error count

(3) `Evp Tx 000000` Transmitted envelope errors (Master mode only) This is 1/6 Data error count

The time display simply shows the time since the test has started in seconds.

For example | Time 000010 | If the count is stopped the display is | T Stop 000010 |

If the count has been aborted the display is | T Abort 000010 |

5.4.7 Lamp Test

This facility is used to check the LEDs and the LCD display.

To activate the test choose the item | T > Lamp Test |

When SELECT is pressed the LCD should show a line of blocks, and the LED's should light up, for about 3 seconds. On completion the above display is returned to.

5.4.8 Self Test

The *Self Test* facility does some simple checks on the EPROM and the EEPROM and can be activated by two means:

(1) On initial power on.

(2) Selection in the test menu.

It is activated in the menu by selecting the item `T> Self Test`

The displays are then as follows:

1. `Testing`
2. `Self Test Pass` or in the case of failure:

`EPROM Fail` or `EEPROM Csum Fail` or `EEPROM Fail`

Menu activated self test will display a few more deatils:

1. `EPROM Test` (This is just a breakdown of the testing procedure in step 1 above)
2. `EEPROM Test`
3. `Blocks Used 000` (This indicates the amount of space left in the EEPROM)
4. `Self Test Pass` or in the case of failure:

`EPROM Fail` or `EEPROM Csum Fail` or `EEPROM Fail`

5. `LTU 2.0 28-2-90` AM64000A (This indicates the software version number fitted.)

`AM19200 Ver 1.0` AM19200A (This indicates the software version number fitted.)

The EEPROM size is designed to be sufficient for the expected lifetime of the BBM, (2×10^6 write operations). However, the usage of the EEPROM (Blocks Used) is still displayed for information.

For example;

0 means that the first block is in use and that there are 254 empty blocks, (each block has 10^4 writes)

254 means that the last block is being used and the chip is nearly full, (and needs replacing).

The failure messages have the following implications:

1. *EPROM Fail* This is a fatal error and the program will terminate.
2. *EEPROM Fail* This indicates that the internal structuring of the EEPROM data is corrupt. If this happens an opportunity is given to reset the EEPROM.

To reset the EEPROM, press the SELECT key in response to the | Reset EEPROM ? | prompt.

The consequence of resetting is that some sections of EEPROM memory may be written to more than the recommended maximum number of times, giving ultimately lower reliability of saved data.

3. *EEPROM Csum Fail* This indicates that data in the non-volatile memory (EEPROM) has an incorrect checksum. This can occur during normal usage if the unit was programming a new configuration when the power was turned off. Normal operation can resume, but the set up configuration must be re-entered.

5.4.9 Communication Channel Loopback

This loop is very similar to the remote loop feature in that it still applies the loopback at the remote BBM. The main difference is that the command to turn on the loop is sent via the comms channel (see Appendix D). This means there is no reliance on the status line to control the loop. The loop can therefore be applied at all rates, even 64kb/sec. Unstructured data or data with the status line off can be sent around this loop; whereas a normal remote loop would be cancelled as soon as the status line was turned off.

To activate this loop select the item | T> Comm Loop Off |

The display should then show | T> Comm Loop On |

The loop should be applied and the TM LED should come on.
Note that the status menu treats this loop differently in that the top level display is NOT *Loop Active* but *Data Transfer* etc.

5.5 Rate Menu

The rate menu is only accessible in master mode. In slave mode the user rate is dictated by the master BBM, and the rate can only be viewed from the display in the status menu.
The menu consists of a number of rates from which one is selected. The actual rates available depend on the X21 / X21bis setting, and the type of modem being used ; only four user rates are available on the AM19200A.
When the rate menu is entered the initial display is that of the current rate. The display shows the word *Rate* next to the prompt to indicate this. All of the other rates are indicated by the number alone.
To view the selection of rates use the SCROLL keys. The rates increase as you go down through the list.

For example:

If the rate 4.8k is viewed only then the display is `R > 4.8K`

If the rate 4.8k is currently in use then the display is `R > Rate -- 4.8K`

To change the rate, locate the desired rate and press SELECT.
The display should then change (as shown above for 4.8k) to indicate that the new rate has been selected.

The full list of available rates for the AM-64000A are as follows (all shown as though they were selected);those available on the AM-19200A are shown highlighted:

`R > Rate -- 2.4K`	(AM-19200A)
`R > Rate -- 4.8K`	(AM-19200A)
`R > Rate -- 9.6K`	(AM-19200A)
`R > Rate -- 16K`	High rate only,unstructured rate (ie. no status line)
`R > Rate -- 19.2K`	(AM-19200A)
`R > Rate -- 32K`	High rate only, unstructured rate
`R > Rate -- 48K 10`	High rate only, normal 48K mode
`R > Rate -- 48K d2`	High rate , X21 only, X22/X50 division 2 with frame pulse
`R > Rate -- 48K d3`	High rate, X21 only, X22/X50 division 3 with frame pulse
`R > Rate -- 56K`	High rate only
`R > Rate -- 64K`	High rate only, unstructured rate
`R > Rate -- 64K BT`	High rate , X21 only , unstructured rate with byte timing pulse

With the AM-64000A the menu operates slightly differently when the *64k mode* is activated. This mode is not available on the AM-19200A . It is described more fully in the section on the Configuration Menu. Briefly, this mode involves the master BBM set to 64K +BT, and the slave BBM set to some other rate. As far as the rate menu is concerned there are now two separate rates to display; and these are indicated clearly with the words *master* or *slave*. The SELECT key now only defines the slave rate, the master rate remains at 64k +BT until the 64k mode is disabled.

The master BBM (local) rate is indicated by | R> Master 64K BT |

The slave BBM (remote) rate is indicated by | R> Slave 4.8K |

The slave rate is always displayed first on entry. The master rate has to be scrolled to.
Upon deselecting the 64k mode in the configuration menu both master and slave rates revert to 64k + BT.

5.6 Option Menu

This menu configures the type of DTE interface used with the BBM.
There are three main selections to make:

(1) Overall protocol type	X21 or X21bis
(2) Interface type	V11, V28, or V35/V36
(3) Control line options	105 set on 108/1 set on, 106 delay, 107 = 108/1.

This can be explained more clearly by considering the operation of the menu:
The top level display will show X21 or X21bis, the SELECT key toggling between the two.

The X21 mode is shown as `O> X21`

The X21 bis mode is shown as `O> X21 bis`

5.6.1 X21

If X21 mode is selected then the next line will always be `O> V11 Interface`

All the V11 interface lines are found on the 15 way D-type back panel connector. (See appendix A).
There are no other interface options in X21 mode.

5.6.2 X21 bis

If X21 bis mode is selected then there is a choice of two interface types (toggled by pressing SELECT).

(1) `O> V28 Interface`

(2) `O> V35 Interface` This is selected for both V35 AND V36.

If the V28 interface is selected then all of the interface lines emerge on the 25 way D-type back panel connector.
If the V35 interface is used then the V35 or V36 adapter must be fitted which plugs into both back panel connectors.
(See appendix A for connection details).

There are four control line options which can be applied to the X21bis V28 interface.

(1) `O> 105 Normal` press SELECT `O> 105 Set On`

This simply holds the control line 105 ON internally

(2) | O> 106 Normal | press SELECT | O> 106 Delay |

This provides a 15ms delay between the line 105 going ON and line 106 going ON.

(3) | O> 107 Normal | press SELECT | O> 107 = 108/1 |

This allows control line 107 to follow control line 108/1 independent of other factors.

(4) | O> 108/1 Normal | press SELECT | O> 108/1 Set On |

This option holds the control line 108/1 ON internally.

There are three options for the X21bis V35/V36 interface.
(1) and (2) as before

(3) | O> 107 Normal | press SELECT | O> 107 Set On |

This holds control line 107 ON permanently.
There is no control line 108/1 directly associated with V35/36, so it is held ON internally. This means that although it is not displayed, the option *108/1 Set On* is active in V35/36 mode. When the mode is exited, eg. changed back to V28, no memory of the previous state of this option remains. The option is therefore left on. So when changing from V35/36 to V28 it must be remembered that the option *108/1 Set On* will be active, and should be deselected if not required.

5.7 Configuration Menu

This menu contains items that are used in the initial configuration of the BBM. Once set up they are not usually required for normal BBM operation. All of the configuration parameters are stored in non volatile memory, and are restored the next time the BBM is powered up.

The items in this menu are as follows:

(1)	Master / Slave	
(2)	Line rate	only available with the AM-64000A
(3)	X21 loop control	
(4)	Synchronisation type	
(5)	64k mode	only available with the AM-64000A
(6)	Transmit power level	
(7)	Menu lock	

5.7.1 Master / Slave

When two BBMs are connected together, one BBM has to be a master, and the other one a slave. The transmission signal is different for master and slave, so line synchronisation will never be achieved if two like types are connected together.
Normally it makes no difference which end is which, but there are a few extra facilities included in the master mode.

These are:

(1) Selection of the user data rate, (see section 5.5).
(2) External bit/byte timing synchronisation, (see section 5.7.4).
(3) Provision of 64k mode, (see section 5.7.5). (only available with the AM-64000A)
(4) Extra error monitoring facilities, (see section 5.4.6).

The master display is **C> Master Mode**

Pressing SELECT gives the slave display; **C> Slave mode**

5.7.2 Line Rate (AM64000A only)

The line rate is the basic bit rate of the transmission between the two BBM's.
There are two settings *high* and *low*. The low rate gives a better range, but lower user data rates.

The high rate is shown **C> High Rate** pressing SELECT gives the low rate, shown **C > Low Rate**

The high rate is 71.1kb/sec, and all user data rates are allowed. The range depends upon the cable dimensions, an example is 5km of 0.4mm cable, (corresponding to 50dB attenuation).

The low rate is 28.4kb/sec, and all user data rates up to 19.2kb/sec (except 16kb/sec) are allowed. The range on 0.4mm cable is extended to 8km, (50dB attenuation).

5.7.3 X21 Loop Control

This facility is designed for when a pair of BBMs are used as an extension to another BBM link.
The concept is shown in figure 5.7.3

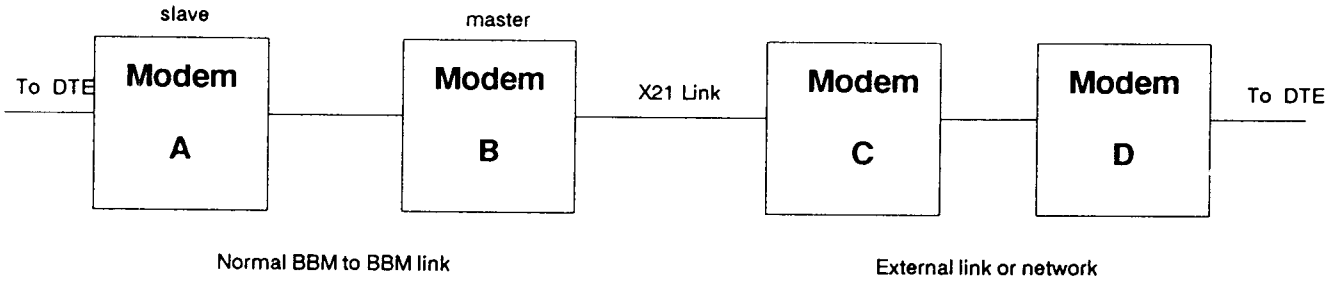


Figure 5.7.3

BBM's A and B form part of a conventional link. However, instead of a DTE being connected to BBM B another link is started with BBM C. This BBM may then be connected to another BBM (shown as D) or even a line card feeding into a network. (Details of the second link are not important at this point). If BBM A (or the DTE connected to A) attempts to apply a remote loop the loop will normally be applied at B. However if the *X21 loops off* option is applied at B , then the remote loop command will travel through to BBM D. The remote loop has thus been applied at the very far end of the network. The option effectively tells the BBM (B) to ignore any loop requests from the line; any internally activated loops (ie. from the front panel) behave as before. Note also that if the option is applied the RX NRDY LED in BBM B will not function, this is because all the data is now treated as unstructured data. (No status line so Not Ready patterns have no meaning).

The normal loops on mode is shown in the menu as `C> X21 Loops On`

Pressing SELECT turns the loops off, shown as `C> X21 Loops Off`

5.7.4 Synchronisation Type (AM64000A only)

This option is only applicable to master mode with external timing.
This option allows the user to change the type of clock synchronisation within the BBM.

Normally in a point to point link, the master BBM becomes the source of timing and the slave BBM locks to this. If a further link is driven as shown in figure 5.7.3, then the *external* BBM (C) must supply a source of timing to the master BBM (B). This timing can be of two forms Bit Timing, or Byte Timing.

Bit timing is selected with the display `C> Bit Sync`

This is the only relevant selection for the AM19200A. The Bit timing signal must be of the same frequency as the user bit rate. The circuitry is designed to be supplied with the timing clock output from another BBM.
The signal connections are via the X21 / X21bis interface connectors, (see appendix A).

The Byte timing signal is shown by `C > Byte Sync`

(Not shown on AM19200A).
The Byte timing signal must be a 1/2 bit wide pulse every 8 data bits. The circuitry is designed to accept the byte timing output from a slave BBM operating at 64kb/sec.
The signal connections are via the X21 / X21bis interface connectors, (see appendix A).

5.7.5 64k Mode (AM64000A only)

This mode is designed to be used in association with the X50 framing patterns. When the mode is selected the master BBM is set to 64k and the slave to (usually) 48k X50. This allows the master BBM to become transparent to the X50 framing structure, allowing it to be processed by the master DTE.

The mode is normally OFF displayed `C> 64K Mode Off` pressing SELECT gives

`C> 64K Mode ON`

5.7.6 Power Level

This items selects the output power level of the transmission circuitry. There are two options:

`C> Power 10 dBm` high power

`C > Power 0 dBm` low power

The 10dBm option should normally be selected. The 0dBm option should be selected for short lines to reduce interference to other equipment.

5.7.7 Menu Lock

This item allows the user to restrict accidental use of the menus.

The normal mode is displayed: `C> Menu Unlocked`

When the menu is locked the display changes to `C> Menu Locked`

When locked the SELECT key is disabled, and no items in *any* menu can be altered.
The only option available is to *unlock* the menu.

In order to prevent easy locking and unlocking the SELECT key does not function in the normal way for this feature.
The lock is activated by selecting the *STATUS MENU* and then pressing three keys simultaneously.

These keys are (1) left menu key
(2) SELECT key
(3) TX NRDY key

In order to prevent activation of the TX NRDY feature the keys should be pressed in the order above.

When these keys are pressed the display will show:

`>> Menu Locked`

This message will be displayed for about 3 seconds before reverting back to the status display.
The menu is now locked and if the configuration menu is examined it will display the locked message.

Pressing the same three keys again will unlock the menu;

`>> Menu Unlocked`

The operation is a toggle action (ie. lock - unlock - lock), just like the normal SELECT key operation.

GLOSSARY OF TERMS

AIS	Alarm Indication Signal.
ALT	Automatic Local Test. - Pattern sent to apply a local loop in the DCE.
AMI	Alternate Mark Inversion. - Code used for line transmission.
ART	Automatic Remote Test. - Pattern sent to apply a loopback on the remote modem.
BBM	Base Band Modem.
BT	Byte Timing. - Synchronisation to every 8 bits.
BT	British Telecom.
CCITT	International Telegraph and Telephone Consultative Commitee.
CNR	Controlled Not Ready
DCE	Data Circuit-terminating Equipment.
DTE	Data Terminating Equipment.
EEPROM	Electrically Eraseable Programmable Read Only Memory.
LCD	Liquid Crystal Display
LED	Light Emitting Diode.
LTU	Line Terminating Unit. Same as Base Band Modem AM-19200A and AM-64000A.
UNR	Uncontrolled Not Ready.
V11	CCITT specification. Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.
V24	CCITT specification. List of definitions for interchange circuits between DTE and DCE.
V28	CCITT specification. Electrical characteristics for unbalanced double-current interchange circuits.
V35	CCITT specification. Data transmission at 48kbit/s using 60-108kHz group band circuits.
V36	CCITT specification. Modems for synchronous data transmission using 60-108kHz group band circuits.
X21	CCITT specification. Interface between DTE and DCE for synchronous operation on public data networks.
X21 bis	CCITT specification. Use on public data networks of DTE which is designed for interfacing to V-series modems.
X50 Div 2/3	CCITT specification. Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks. (80 and 20 bit patterns).

GENERAL SPECIFICATION

Transmission system uses DSP techniques involving echo cancellation and adaptive decision feedback equalisation.

Power output selectable 0dBm or 10dBm.

Line code is AMI with embedded sync pattern for timing control.

Line rates 71kbit/s (high) or 28kbit/s (low).

Note : AM-64000A allows both high and low line user rate.
AM-19200A allows only low line user rate.

Line attenuation range up to 50dB (at 10dBm output level).

High line rate user data rates : 2400,4800,9600,16000,19200,32000.48000,56000,64000 bit/s.
Low line rate user data rates: 2400,4800,9600,19200 bit/s.

Synchronous working at all user rates, Asynchronous working at 2400,4800,9600 and 19200 bit/s.

Most options and features software configurable.
Front panel lockable to prevent unauthorized operation

Byte timing is available at 64kbit/s with the X21 interface on the AM-64000A.
X50 divisions 2 and 3 are supported at 48kbit/s on the AM-64000A.

User interfaces: X21 V11
X21 bis V28
X21 bis V35
X21 bis V36

Test facilities: local loop, loopback, remote loop, comms channel loop,
transmit binary 0, transmit binary 1, transmit CNR,
self test, lamp test, data channel error test, in service error test.

Enviromental conditions:

Temperature range	+5 to +40 deg C
Humidity range	5% to 85%
Air pressure range	70 to 106 kPa

Power supply: 240V +6 to -10%, 50Hz +5 to -5%

Upgrade: The AM-19200A is upgradeable to full AM-64000A specification.

APPENDIX A - Interface Pin Connections

25 Way D-Type X21 bis (V28) Connector pin allocation

Pin	Circuit	Description
7	102	Common Return
2	103	Transmitted Data
3	104	Received Data
4	105	Request to Send
5	106	Ready for Sending
6	107	Data Set Ready
20	108.1	Connect Data Set to Line
8	109	Data Channel Received Line Signal Detector
15	114	Transmitter Signal Element Timing (DCE)
17	115	Receiver Signal Element Timing (DCE)
21	140	Remote Loopback for Point-to-Point circuits
18	141	Local Loopback
25	142	Test Indicator
24	113	External Transmitter Signal Element Timing
9	VDD	+ 12V Supply for V36 adapter
10	VSS	- 12V Supply for V36 adapter

15 Way D type X21 (V11) Connector pin allocation

Pin			Circuit	Description
A-wire	B-wire	Unbal		
		8	G	Signal Ground / Common Return
15	1		SEXT	External Signal Element Timing
2	9		T	Transmit
4	11		R	Receive
3	10		C	Control
5	12		I	Indication
6	13		S	Signal Element Timing
7	14		B	Byte Timing
7	14		F	Frame Start Identification

V35 (MRAC) Connector Pin Allocation

Pin			Circuit	Description
Unbal	A wire	B wire		
B			102	Common Return
	P	S	103	Transmitted Data
	R	T	104	Received Data
C			105	Request to Send
D			106	Ready for Sending
E			107	Data Set Ready
F			109	Data Channel Received
	U	W	113	External Transmitter Signal Element Timing
	Y	AA*	114	Transmitter Signal Element Timing
	V	X	115	Receiver Signal Element Timing
N			140	Remote Loopback
L			141	Local Loopback
NN*			142	Test Indicator

Note that to operate with a V35 interface, the separate V35 Adaptor must be used (see section 2.1)
Note that on some MRAC connectors pin 'AA' is marked as 'a' and pin 'NN' is marked 'm'.

37 Way D type V36 Connector pin allocation

Pin			Circuit	Description
Unbal	A wire	B wire		
19,20,37			102	Common Return
	4	22	103	Transmitted Data
	6	24	104	Received Data
7			105	Request to Send
9			106	Ready for Sending
11			107	Data Set Ready
13			109	Data Channel Received
	17	35	113	External Transmitter Signal Element Timing
	5	23	114	Transmitter Signal Element Timing
	8	26	115	Receiver Signal Element Timing
14			140	Remote Loopback
10			141	Local Loopback
18			142	Test Indicator

Note that to operate with a V36 interface, the separate V36 Adaptor must be used (see section 2.1)

LINE CONNECTOR.

The line connections are pins 1 & 6 from the telephone style cord.

APPENDIX B - Asynchronous Interface

The asynchronous interface operates at four data rates, these are: 2400, 4800, 9600, and 19200 bits/sec.
The BBM can be set up in asynchronous mode for other data rates but no data transfer is possible.
To configure the BBM for asynchronous mode the internal links must be changed. The layout and details of these are shown in appendix C. There are 4 links to be set:

(1) J16 Signalling rate
(2) J17 Character length 1
(3) J18 Character length 2
(4) J19 Asynchronous enable

1. Signalling rate

The usual position for this link (J16) is 1-2. This is termed the *basic signalling rate,* and in normal use this link will not need to be moved. The basic signalling rate allows a the asynchronous bit rate to have a tolerance of -2.5% to + 1%, (or better).
The BBM can still cope if the asynchronous bit rate has a tolerance of -2.5% to + 2.3%. In this case the link must be moved to position 1-3. This is now termed the *extended signalling rate.*
If the tolerance of the asynchronous bit rate is any wider then the system will not be able to cope.
The extended signalling rate should only be used when nessessary, as it can shorten stop bits by 25% which may ultimately lead to more data errors.

2 and 3. Character Length

The character length must be set up for the particular asynchronous interface used, and must be set up indentically for both master and slave BBM. The set ups are as follows:
Note: the character length above is the total length including one start bit, one stop bit and possible parity bit.

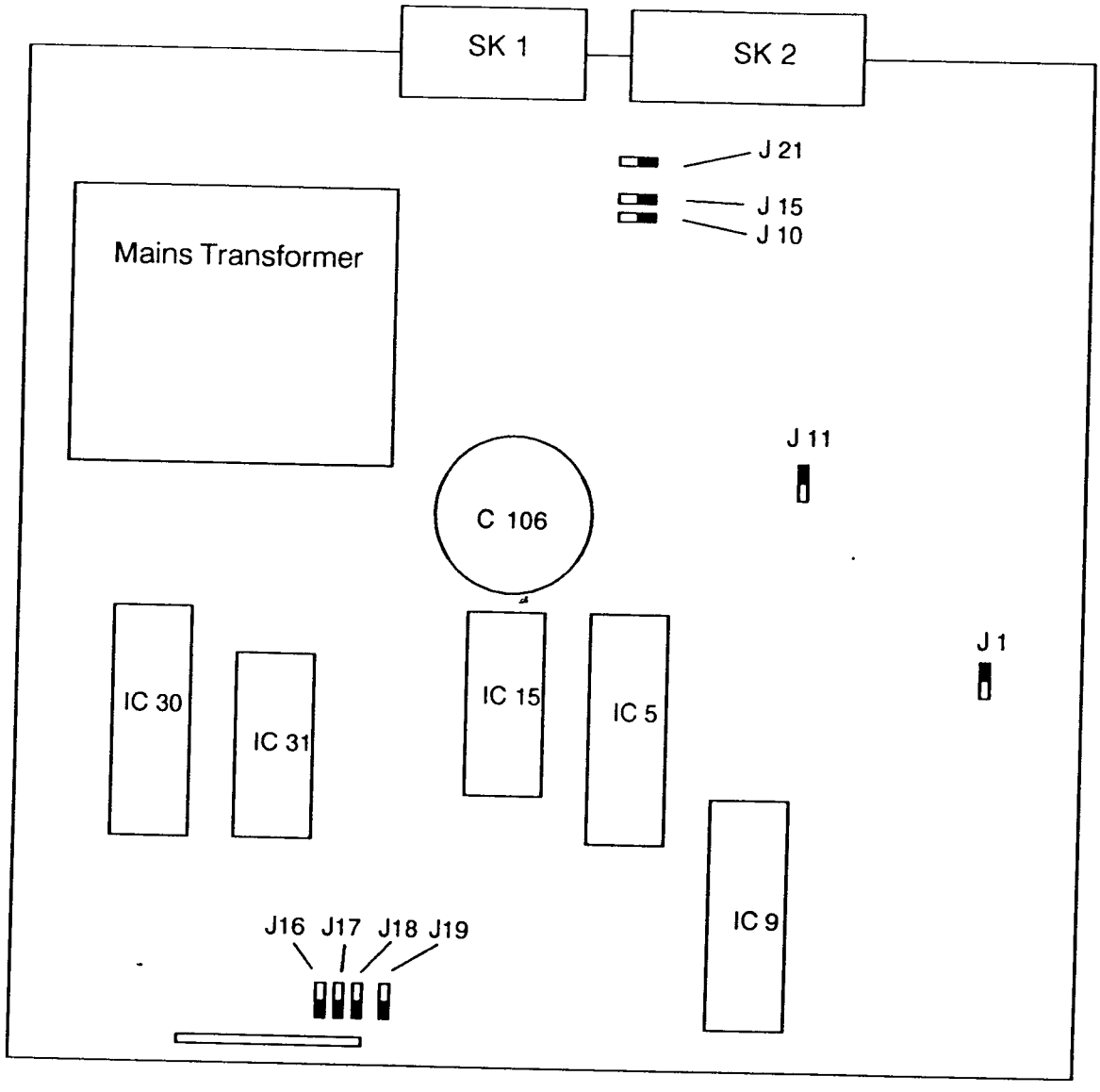
Link Position J17	Link Position J18	Character Length
1-3	1-2	8 bits
1-3	1-3	9 bits
1-2	1-2	10 bits
1-2	1-3	11 bits

4. Asynchronous Enable

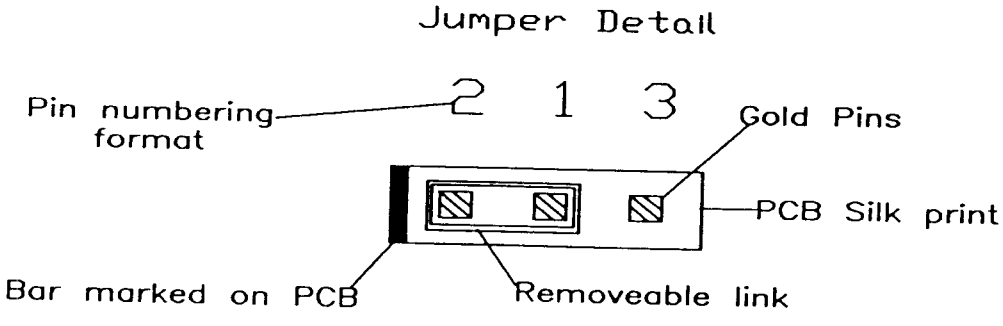
This link (J19) should be set in position 1-3 for asynchronous working and 1-2 for synchronous working.

APPENDIX C - Internal Link Settings

The following diagram shows the location of the internal BBM links:



All of the links have 3 pins, the bar end indicating pin2



The function of the links is as follows:

J1 Transmission disable
This link is always left in position 1-2

J10 Termination resistor for X21 T circuit (Transmit data)
This link connects a 120 ohm load resistor across the T circuit in position 1-3. This helps to maintain the signal rise time and minimise reflections at rates greater than 9.6kb/sec over long lines. It also provides termination for cct 103 at the V35 interface. At lower rates and over short lines the termination resistor may be omitted, (link set to 1-2).

J11 Watchdog enable
This link is always left in position 1-2

J15 Termination resistor for X21 S EXT circuit, (External Signal Timing)
This link connects a 120 ohm load resistor across the S EXT circuit in position 1-3. (Similar to J10).
IMPORTANT - This link must be left in position 1-3 (terminated), otherwise the BABT approval will be invalidated.

J16 Signalling rate - see appendix B on asynchronous interface.

J17 Character length 1 - see appendix B on asynchronous interface

J18 Character length 2 - see appendix B on asynchronous interface

J19 Asynchronous enable - see appendix B on asynchronous interface

J21 This connects the mains earth to the circuit ground in position 1-3
The circuit ground is floating in position 1-2

WARNING

Only authorised personnel can be allowed to open the Line Terminating Unit case to change the link settings. Misuse or any modifications carried out to this unit other than in accordance with the instructions supplied, will invalidate both the guarantee and the BABT approval.

APPENDIX D - In Service Test Background Information

D.1 Frame Structure

The information passing between master and slave BBM's comprises user data and control data; the latter is used for controlling and supervising the operation of the transmission system. In order that these components can be separated the composite data is transmitted in frames with a fixed framing pattern to identify the frame boundary. Data is transferrred at 71.1 kb/sec at the high rate and 28.4 kb/sec at the low rate. For both rates the frame structure is the same. Figure D.1 shows the basic frame structure.

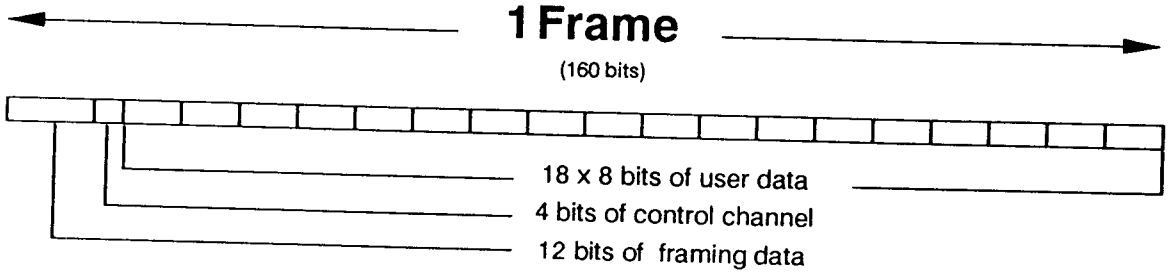


Figure D.1

Each frame consists of 160 bits of which 12 are allocated to the framing pattern and 4 to the control channel. (These 4 bits per frame are termed the *Comms channel*). This leaves 144 bits, or 18 octets for user data. With most rates the user data actually occupies 6 bits out of every octet, as one bit is used as the user status line, and the other bit is used as an *envelope alignment bit* , (this bit is used by the system for the multiplexing of lower user rates into the 71.1 / 28.4 kb/sec overall bit rates). There are several user rates which do not have an alignment bit; these are 16, 32, 56, and 64 kb/sec, consequently these rates will not be able to use the envelope alignment error monitoring schemes. At the high rate the maximum throughput for the user is 64kb/sec (no status, no alignment); at the low rate it is theoretically 25.6kb/sec but is reduced to 19.2 kb/sec by the channel structure (1 status + 1 alignment)

D.2 In Service Test Facilities

The In Service Test has access to two basic sources of information:

(1) The envelope alignment bits

(2) The comms channel

The use of the envelope alignment bits is slightly more straight forward.
At either end of the link the BBM monitors these alignment bits against tables held in ROM. Any bits received in error are counted and can be displayed. For each frame there are 18 envelope alignment bits for 18 x 6 bits of data. The effective data error rate can then be found from:

$$\text{Bit Error Rate (BER)} = \frac{\text{Envelope Error Count} \times 6}{\text{User Data Rate} \times \text{Time}}$$