Radiometrix Limited

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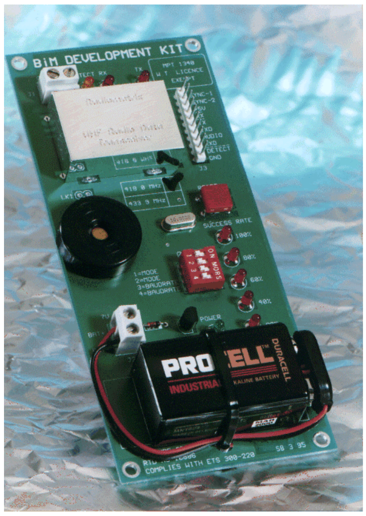
BiM Evaluation Kit

Evaluation Kits *BiM-Eval-418-A, UK version*
BiM-Eval-433-A, Euro version



The BiM-Eval-418-A and BiM-Eval-433-A are evaluation boards especially designed for development and measurement purposes for our half duplex Bi-directional UHF-radio data modules (BiM). The evaluation board is based on a microcontroller design which integrates several modes. Transmission responses up to 40 kbps can be monitored.

Range of facilities include:

- Range testing;
- Target environment testing;
- Interference identification;
- Antenna evaluations;
- BiM hardware test;
- BiM transient analysis;
- Communications eye diagram;
- Linking external hardware;
- Responses up to 40 kbps

The concept is based upon a microcontroller (PIC16C57) design, which monitors and controls all the necessary data and control lines. Some of the available modes on the board will show the unit's response with transmission speeds up to 40kbps.

Both operation mode and transmission speed can be defined by the user, simply by selecting the required positions on the provided DIL-switch. Status LED's have been provided to indicate whatever status the unit is in (i.e. transmitting or receiving), including a 5-bank LED success rate indicator to reflect the communication performance.

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1. GETTING STARTED

Please read the following chapter carefully before doing anything. First of all make sure that the contents of the purchased evaluation kit includes everything. In the unlikely event of missing products or documentation please call our sales department immediately.

The BiM evaluation kit should include the following components and documentation:

- BiM Evaluation Kit PCB — Quantity: 2
- 9V battery (PP3) — Quantity: 2
- Whip antenna — Quantity: 2
- BiM Evaluation Kit manual — Quantity: 1
- BiM-UHF data sheets — Quantity: 1

In addition to the above a 2-channel oscilloscope (preferably with digital storage) is highly recommendable to visualise the unit's operation. For this purpose two sync outputs are specially implemented for monitoring the unit's operation. Next chapters will give a comprehensive description of all available modes, including some relevant oscilloscope traces to show the measured signals.

N.B.

Care should be taken with the polarity of the terminal connections when external power is applied. The supply range may vary from +8.0V DC up to +15.0V DC.

Only one of the two provided PCB's incorporates a wired link on the board (LK1). This is to avoid any communication synchronisation clashes between the two units. The link also provides some additional features in some modes.

2. SYSTEM'S AVAILABLE MODES

An easy hand held design has been created for mobile use or work bench purposes. The 4 way DIL-switch can be configured by the user to operate in one of the four available modes. Following list will highlight the 4 provided modes on the board.

MODE-1:
During this mode a message will be transmitted forwards and backwards (Ping-Pong mode-1) with 1/4-3/4 mark/space ratio protocol. A TX & RX-LED will show if the BIM is in TX & RX mode, respectively. To visualise the communication's performance a bank of LED's is provided as well to make data hits or misses audible.

MODE-2:
This mode (Ping-Pong mode-2) is similar to the first mode, however this transmission protocol being used is based upon ASCII Non Return Zero (NRZ) signal. Both Ping-Pong modes can either be configured to operate with transmission speeds of 4800, 9600, 14400 or 19200 bps.

MODE-3:
A 511 pseudo random bit generator protocol has been implemented in this mode to check the communication's performance. By triggering both units correctly (with the available synchronisation pulses) a communication eye diagram can be produced on an oscilloscope.

1. *LK1 fitted* : Unit operating in continuous transmitter mode
2. *LK1 not fitted* : Unit operating in continuous receiver mode

The transmitter unit can be configured to operate with transmission speeds of 4800, 9600, 19200 or 38400 bps. Status LED's are TX, RX and CD. On the receiver unit the received data or noise will be audible through the buzzer.

MODE-4:
This last mode will offer two combined facilities (listed below). The state of the link (LK1) on the board will determine what mode it is going to operate in.

1. *LK1 not fitted* : During this mode a transient analysis of the radio performance will be made so that all the response times of the BIM itself can be viewed on an oscilloscope. Only one unit is required in this mode.

2. *LK1 fitted* : Now the unit will be in tristate mode. This will actually allow to have own add-on cards connected to the BiM Evaluation Kit, to perform other external tasks.

MODE-1

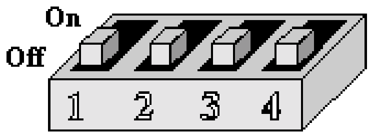
3. MODE-1 (PING PONG, 1/4-3/4 FORMAT)

In this mode a special 1/4-3/4 mark/space ratio protocol is being used to transfer a 6 byte data string forwards and backwards. Following paragraphs will explain explicitly how to configure this mode and how to measure the relevant signals.

3.1 CONFIGURING MODE-1

Following pictures and table (fig 3.1 & fig 3.2) will outline the settings of the DIL-switch to configure it to this particular mode and the required transmission speed respectively.

FIG 3.1



Mode 1 can be selected by configuring switch 1 & 2 to the OFF-position. By setting switch 3 & 4 to one of the four combinations as shown below, in table 3.2, the required transmission speed can be selected.

TABLE 3.2

Switch 3	Switch 4	Speed
Off	Off	4800
Off	On	9600
On	Off	14,400
On	On	19,200

N.B. Every time a new mode or speed has been configured the reset button has to be activated to enter this mode! It will then start its run procedure automatically. To operate this mode two units are required. Only one of these two units should have the wire link (LK1) connected. This is to avoid communication clashes between the units. The first few transmissions after resetting might fail while the initialisation process is being carried out.

3.2 VISUAL & AUDIBLE FACILITIES

Status LED's will be activated as the units are performing their program to show the unit's status. Following LED's will be driven:

- TX: transmitter enabled;
- RX: receiver enabled;
- DETECT: presence of carrier signal.

Apart from the status LED's the performance of the communications will be visualised as well. A 5-LED success rate indicator has been provided to show the percentage of hits and misses during the operation. Every LED represents an increment or decrement of 20% success or failure respectively. If a miss occurs or an out of range situation happens a decrement of 20% will be shown. The units then automatically will try to re-establish communications again.

A short high frequency beep will be outputted to the buzzer upon receipt of a successful transmission. In case of a transmission failure or out of range situation, a longer low frequency beep will be produced.

3.3 MEASURING THE RADIO SIGNALS

Two trigger outputs (Sync1 & Sync2) have been provided through a 10 pin header to trigger the transmitted data and received data respectively. With those two trigger outputs it is possible to have a closer look at the implemented radio communication protocol. An digital storage oscilloscope would be a useful measurement tool for this facility.

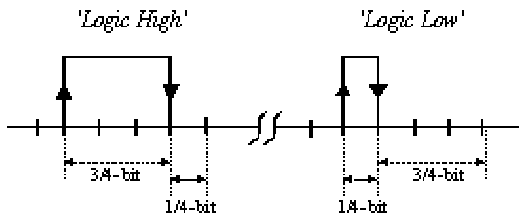
3.3.1 MEASURING THE TRANSMITTED DATA

Trigger output **SYNC-1** actually allows to examine the transmitted data string. The transmitted data string has the following sequence:

- Preamble : 4ms fixed 9600bps bit pattern to bias the receiver;
- Fixed low period : fixed 2ms logic LOW to show the bias balancing effect;
- Fixed high period : fixed 2ms logic HIGH to balance the previous low period;
- Start bit : to introduce start of data string (bit speed user defined);
- Data string : fixed 6 byte data string (bit speed user defined).

The data bytes are based upon a 1/4-3/4 bit mark/space ratio. Next drawings (fig 3.3) will show how a logic high and a logic low look like.

FIG 3.3

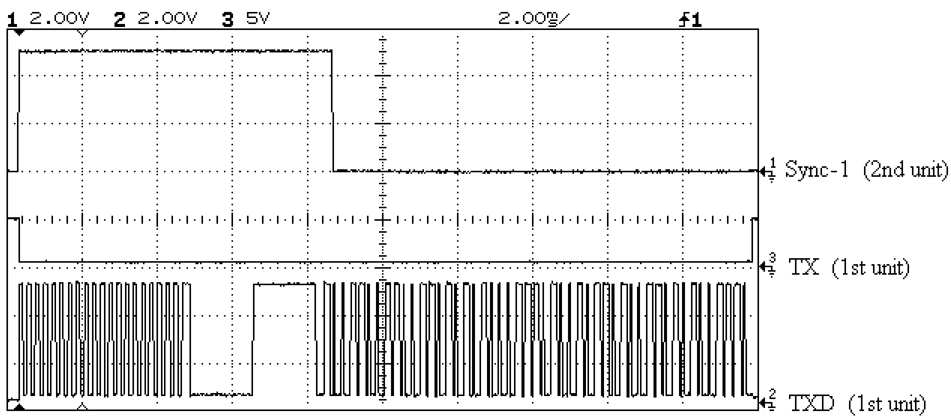


To provide more measuring comfort the data can be viewed on two important places which will be determined by the slope of the **SYNC-1 trigger pulse**. If the scope is configured to trigger on a **positive slope** the start of the transmitted data string can be triggered.. Where if the oscilloscope is configured to a **negative slope** the start of the 6 data bytes can be triggered. So by using this negative slope the following signals will be by-passed:

- preamble;
- fixed low period;
- fixed high period.

This has been done to obtain a better view of the actual data bytes. Following drawing, figure 3.4, outlines the oscilloscope traces of the transmitted, received and sampled data.

FIG 3.4

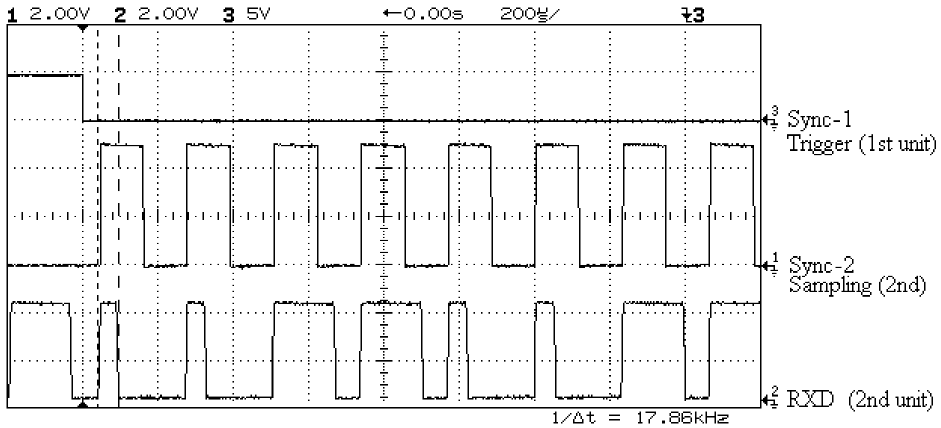


The top trace is the SYNC-1 signal which slope determines either the start of the complete data string or the start of the 6 data bytes. Middle trace shown is the transmitter enable trace (low active). Finally the bottom trace is the shape of the complete transmitted data string (preamble, blank periods and data bytes).

3.3.2 MEASURING THE RECEIVED DATA

A similar synchronisation output, **SYNC-2** (middle trace of figure 3.5), has been provided to show the **sampling points** of the received data. Following figure 3.5 will outline the received data and explain the procedure.

FIG 3.5



The negative slope of the **SYNC-1** (top trace) is **triggering** this measurement. SYNC-1 should be tapped of one of the units separately. Where the middle trace (SYNC-2 = sampling trace) and the bottom trace (RXD = received data trace) will be tapped of the second unit.

Upon reception of the start of a data bit the sync-2 output will create a positive going edge. At the moment where the data is being sampled (approx. 1/2 of bit time) the sync-2 output will create a negative going edge. This way 48 pulses are being created (6 sampled data bytes).

Either audio out (AUDIO) or received data (RXD) can be used as sampling trace with the sync-2 output. The RXD-output will show the actual received data based upon 5V logic signals, where the AUDIO-output shows the received data on AC-level. The AUDIO output will give a good impression of the actual transient signals and times.

MODE-2

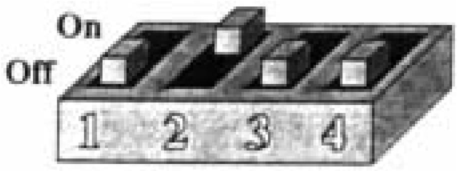
4. MODE-2 (PING PONG, NRZ FORMAT)

Selecting this mode results in a similar mode as mode-1. The only difference is the used transmission protocol. Instead of having a 1/4 - 3/4 mark/space ratio, a true Non Return Zero (NRZ) format has been implemented. Apart from this all procedures are similar to the previous mode.

4.1 CONFIGURING MODE-2

Settings for selecting this mode are outlined in the figure listed below, figure 4.1. After selection the reset push-button should be followed to enter this mode.

FIG 4.1



Mode-2 can be selected by setting switch 1 to the OFF-position, and switch 2 to the ON-position. Switch 3 & 4 will determine the transmission speed again. Refer to the transmission speed look-up table (table 3.2 , chapter 3) to configure the required data transmission speed. Transmission speeds upto 19.2 kbps can be selected in this mode as well.

N.B. To communicate in this mode two units are required as well. After configuring the mode a reset operation should always be followed to enter the required mode and/or speed. Similar to the previous mode, one of the units should contain a jumper on link LK1 to avoid any clashes.

4.2 VISUAL & AUDIBLE FACILITIES

Same visual and audible performance indicators as the previous mode are operating in this mode. Refer to chapter 3.3 for more detailed explanation concerning these facilities. The buzzer will produce a high frequency beep upon receipt of correct data. At the same time the 5-way success rate indicator will be incremented by 20%. If a failure or a time-out period occurs, a low frequency beep will be outputted to the buzzer. Simultaneously the 5-way success rate indicator will decrement by 20%. Status LED's concerning the status of the TX, RX and Carrier Detect lines are provided on the board as well , and are being driven automatically during the process.

4.3 MEASURING THE RADIO SIGNALS

Again the same trigger outputs (Sync-1 & Sync-2) have been provided to trigger the transmitted and received data respectively. A digital storage oscilloscope is recommended for measuring and analysing the radio signals in this mode.

4.3.1 MEASURING THE TRANSMITTED DATA

To analyse the transmitted data protocol a special trigger output has been provided, **SYNC-1**, just like in mode-1. This output allows to examine the transmitted data string on a few specific time intervals. The data string has the following sequence:

- Preamble : 4ms fixed 9600bps bit pattern to bias the receiver;
- Fixed low period : fixed 2ms logic LOW required for receiver to detect data;
- Fixed high period : fixed 2ms logic HIGH to balance previous low period;
- Data string : fixed 6 byte data string (bit speed user defined) including start & stop bit per byte.

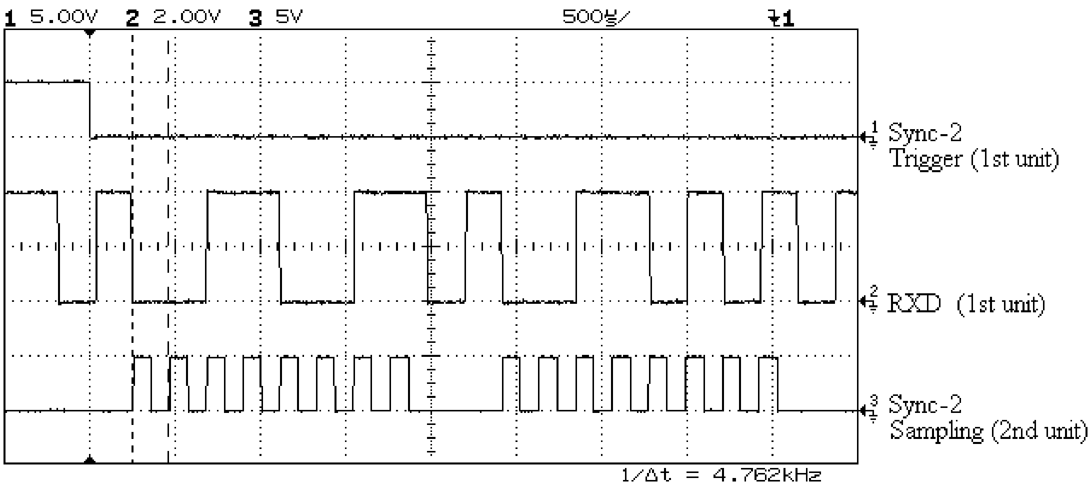
All the bits are based upon a Non Return Zero (NRZ) format. This means that a logic low will be low during 1 bit time, and a logic high will be high during 1 fixed bit time as well. A radio communication problem will be created when a series of logic zeroes are sent. This way a long blank period will be created and a resulting possibility could be that the receiver looses its bias. This problem does not occur with the 1/4 - 3/4 mark/space ratio protocol, because even a series of logic zeroes or ones will still show a changing pattern. Therefore when a NRZ-protocol is being implemented special precautions should be taken to help tackle bias problems (refer to BiM data sheet - Byte coding).

The transmitted data string again can be analysed on two specific time intervals during the data string. Firstly it can be triggered on the **positive going** edge of the sync-1 output (similar to figure 3.4) to trigger the **start of the complete data string** (including preamble). When using the **negative going** edge of the sync-1 output the data string will be triggered on the **start of the first data byte**. This is done when an oscilloscope with a limited memory depth is being used and a more detailed view of the signal is required.

4.3.2 MEASURING THE RECEIVED DATA

Again synchronisation output, **SYNC-2**, has been provided to view the **sampling points** of the received data. Next oscilloscope traces, figure 4.2, outlines the received and sampled data signals of the transmission.

FIG 4.2



Again the **negative slope of SYNC-1** (top trace) of one of the units is being used to **trigger** the start of the 6 byte data string. The SYNC-2 (bottom trace) and RXD (middle trace) have to be tapped of the other unit.

Upon reception of the start of a data bit the **SYNC-2** output will create a positive going edge. At the moment where the data is being **sampled** (approx. 2/4 of bit time) the sync-2 output will create a **negative going edge**. This way 48 pulses are being created (6 sampled data bytes).

Either audio out (AUDIO) or received data (RXD) can be viewed with the sync-2 output. The RXD-output will show the received data based upon 5V logic signals, where the AUDIO-output will show the received data on AC-level. Viewing the AUDIO gives an upright impression of the transient signals and times.

MODE-3

5. MODE-3 (PSEUDO RANDOM GENERATOR)

This mode will configure the units either as continuous transmitter or as continuous receiver. The transmitting unit will continuously send a pseudo random generated signal (explained later on). Where the receiving unit will only be in the receive mode.

A few things are possible during this mode, namely:

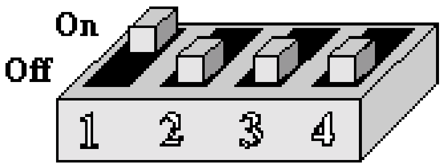
- produce an eye diagram of the communication's performance;
- use the receiver as a of interference detector (both visible and audible).

Following paragraphs will explain how to configure the DIL-switch to this mode, including different data transmission speeds. Furthermore a description will be given of how to obtain a communications eye diagram.

5.1 CONFIGURING MODE-3

To select this pseudo random generator mode switch 1 & 2 should be set to the following configuration, followed by a reset to enter this mode. Switch 3 & 4 will again determine the data transmission speed, however other speeds apply for this mode which are stated in table 5.2.

FIG 5.1



To select the pseudo random generator mode switch 1 should be selected to the ON-position, and switch 2 should be selected to the OFF-position.

The status of the wire link (LK1) will determine whether the unit is going to operate as continuous transmitter or receiver. The status of the link (LK1) implies the following states:

- *LK1 not fitted* : continuous receiver state;
- *LK1 fitted* : continuous transmitter state.

By setting switch 3 & 4 the correct transmission speed can be selected. Table 5.2 , will outline the configuration of switch 3 & 4 for the required data transmission speed.

TABLE 5.2

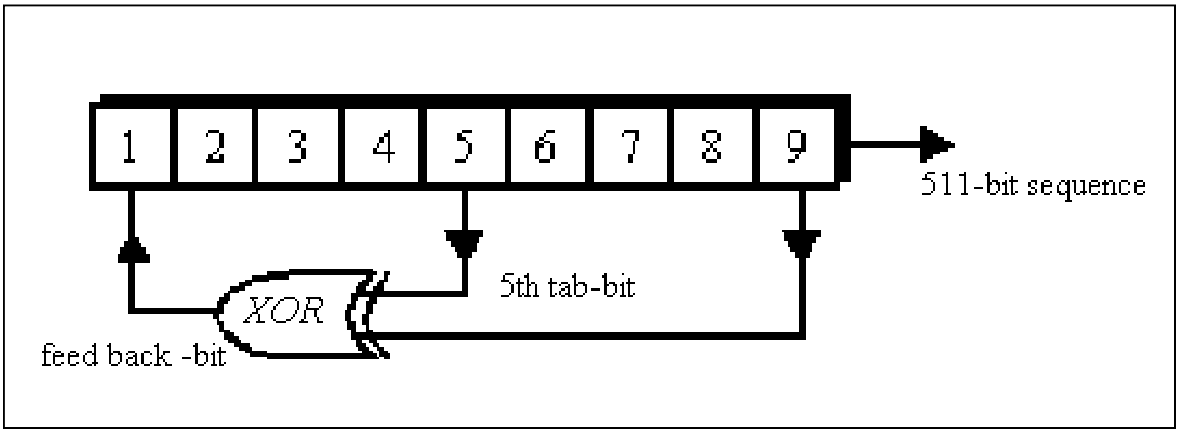
Switch 3	Switch 4	Speed
Off	Off	4800
Off	On	9600
On	Off	19,200
On	On	38,400

N.B. To communicate in this mode two units are required as well. After configuring the mode and/or speed a reset operation should always be followed to enter this required mode and/or speed.

5.2 CONTINUOUS TRANSMISSION MODE

In the continuous transmitter state the microcontroller will generate a pseudo random bit sequence, with a total of 511-bits. The transmission speed can be configured by switch 3 & 4 according to the above table 5.2. A 511-code generator will be created by using a shift register with a special feedback circuit, shown below in figure 5.3.

FIG 5.3



The 511-bit generator is a simple feedback of two taps of a shift register via an XOR gate. Depending on the tap number different sizes of bit sequences can be created. The above outlined configuration will result in the 511-code.

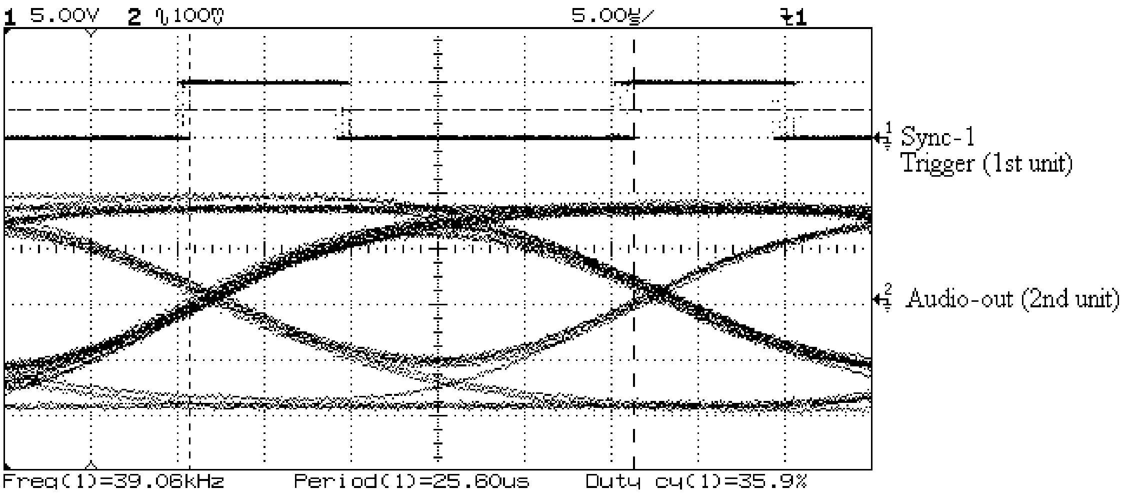
To create a trigger for the eye diagram a **clock signal**, a clock with the data transmission rate of the 511-pattern, has been provided on **SYNC-1**. Next chapter will explain how to obtain the communication eye diagram on an oscilloscope.

5.3 CONTINUOUS RECEIVER MODE

When the unit is configured to this state it can perform two main functions depending on the transmitter unit, namely:

1. If the transmitter unit is on, the receiver unit will receive its data and can produce together with this unit an eye-diagram. SYNC-1 of the transmitter unit will provide a clock signal, which is the trigger input for the oscilloscope (e.g. channel-1). The other input of the oscilloscope (e.g. channel-2) should be connected to the AUDIO output of the receiver unit. By triggering one oscilloscope channel on SYNC-1 (either positive or negative slope) and configure the other channel AC-coupled, a clear communication eye-diagram can be visualised on the screen (preferably with a data transmission speed of 40kbps), see next figure 5.4. The eye diagram provides insight into the performance of the communications going on. The carrier detect LED will illuminate when the transmitter is on to show the presence of the carrier signal. The received data will also be outputted to the buzzer.

FIG 5.4



2. When the transmitter unit is switched off, the receiver unit can be used as a noise / interference location unit archer. Both carrier detect LED and the buzzer will reflect the amount of noise / interference present in the air. This is a very useful facility to determine whether or not some electrical sources are producing interference. Depending on the amount of noise/interference the carrier detect LED will illuminate slightly or brightly respectively. The noise / interference will also be audible through the buzzer.

MODE-4

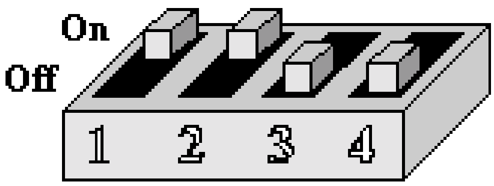
6. MODE-4 (SELF LOOP TRANSIENT TEST & TRANSPARENT MODE)

Finally a special bi-functional mode has been implemented, which will be determined by the status of the link (LK1). Firstly there is a function to analyse the transients of the BiM radio module itself, named self loop test. Secondly there is a function which allows the user to input their own external controller and data signals into the BiM. The microcontroller has got no function in this mode apart from setting the I/O lines in tristate, and therefore is called transparent mode.

6.1 CONFIGURING MODE-4

To select this combined mode switches 1 & 2 should both be selected to the ON-position shown below in figure 6.1, followed by a reset to enter the mode. Data transmission speed can not be selected in this mode, because the self loop transient test is using fixed time loops and the transparent mode speed is externally user defined. With other words **switch 3 & 4 are DON'T CARES** in this mode.

FIG 6.1



This mode can be separated into two modes, depending on the status of the wire link (LK1). The status of the link implies the following modes:

- *LK1 not fitted* : self loop transient test;
- *LK1 fitted* : transparent mode.

6.2 SELF LOOP TRANSIENT TEST

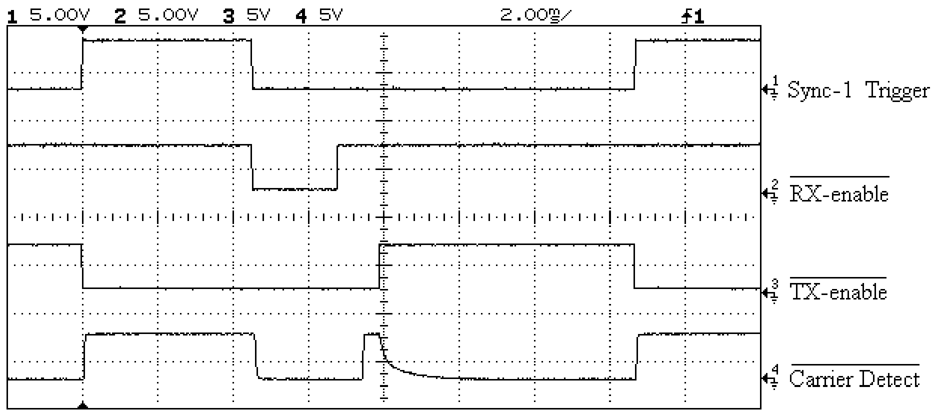
Making transients of the BiM radio module will show the unit's capture and release times. On a repeating time base short internal signals are being generated to test the various times of the radio.

N.B. Only one unit should be used in this mode, because at some moments the radio is testing its own transmitted signals. Therefore other radio signal would interfere the self loop transient test.

6.2.1 MEASURING THE TRANSIENT ANALYSIS

The following oscilloscope traces, shown below in figure 6.2, will present the relevant signals to measure in this process.

FIG 6.2



To trigger the relevant signals the **SYNC-1** output (1st trace from top) will provide a **synchronisation pulse** to trigger the oscilloscope to measure the signals of the self loop transient test. The oscilloscope can be triggered through the sync-1 output either by the:

- **positive going slope**, represents the start of enabling the receiver;
- **negative going slope**, represents the start of enabling the transmitter.

The self loop transient test sequence has got the following sequence.

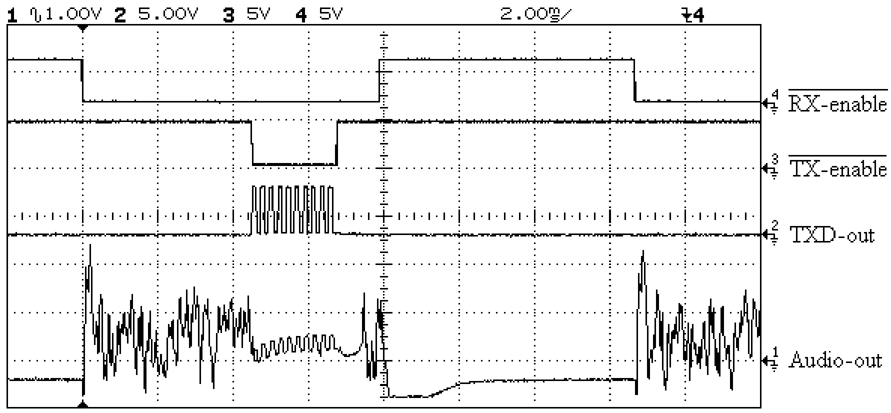
- Upon the positive slope of SYNC-1 the receiver (2nd trace from top) will be turned on (RX = approx. 8ms low active);

- Then after approx. 4,5 ms the transmitter (3rd trace from top) will be enabled as well (TX = approx. 2.3 ms low active), which is triggered by the negative slope of SYNC-1;

- The carrier detect (bottom trace) will be activated (low active) almost straight away when the transmitter is turned on. The transmitter is being disabled 1 ms before the receiver will be disabled. The carrier detect will go back to its logic high level almost straight away again. Apart from the moment where the receiver is turned off again, a 2ms exponential declining signal can be detected;

The traces of the oscilloscope, shown in figure 6.3, contain more relevant signals which can be analysed during this test.

FIG 6.3



- The top and second trace are the RX and TX signals respectively (copied from figure 6.2 to act as reference in this figure);

- During the time that the transmitter is enabled 10 bits of 9600bps will be transmitted (approximately 2ms). This transmitted signal is available on the TXD-pin (3rd trace of above figure);

- The AUDIO-output (bottom trace) will give a clear picture as well concerning the received noise and data. During the time slot where the receiver only is enabled the noise can be recognised. When the short data string is being sent the receiver is trying to bias the signal, and will show a exponential curve of the received data. After the transmitter has been disabled the AF-signal will stay on a fixed level (for less then 1ms) before the actual radio noise will recover again.

6.3 TRANSPARENT MODE

During this mode applied signals will be ignored by the microcontroller (tri-state mode), apart from the carrier detect LED driver monitor. It is up to the user to apply their own signals to the pin header and control the BiM radio themselves. The following lines are available for processing and controlling the BiM radio module:

INPUTS

TX	: transmit enable (low active);
RX	: receive enable (low active);
TXD	: transmit data input.

OUTPUT

RXD	: received data output;
AUDIO	: AF-output;
DETECT	: carrier detect output;
+5V	: positive 5V supply;
GND	: common ground.

N.B. All signals inputted and / or outputted are based upon 5V logic levels. The TX-LED and RX-LED will be hardware driven automatically and therefore do not require any external driver signals.

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Radio and EMC regulations

The Intrastat commodity code for all our modules is: 8542 4090.
The purchaser of Radiometrix subassemblies must satisfy all relevant EMC and other regulations applicable to their finished products.

R&TTE Directive

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment. Further details are available on Radiocommunications Agency (RA) web site: www.radio.gov.uk/document/libind.htm#emc

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