

Project LifeTag System – Technical Description		Development Number D629
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1 Purpose

The purpose of this document is to provide a technical overview of Raymarine's wireless Man Over Board Alarm System, called LifeTag.

The document gives an overview of the method of operation, System Block Diagrams and also details the Wireless Standards to which it complies in terms of Spectrum Usage and Communications Protocol.

2 Reference Documents

2.1 Raymarine

4629-001d LifeTag Schematic

3015-394c LifeTag PCB

4629-008a LifeTag PCB Assembly Drawing

4629-003c Base Station Schematic

3015-395c Base Station PCB

4629-009a Base Station Assembly Drawing

2.2 Non-Raymarine

EM250 Data Sheet 120-0082-000C

EM250 Reference Design 710-0452-000, Rev P3

FE010315-G April 30 2004 Gigaant Mica Antenna Data Sheet

AE020033-D October 2004 Gigaant Picea Antenna Data Sheet

3 Introduction

Raymarine have developed two products that comprise the **LifeTag** Man Over Board Alarm System. They are:

1. LifeTag Base Station
2. LifeTag

The aim of this system is to give an indication to the boat that a member of its crew or a passenger has either left the boat wearing the LifeTag or is in need of immediate assistance.

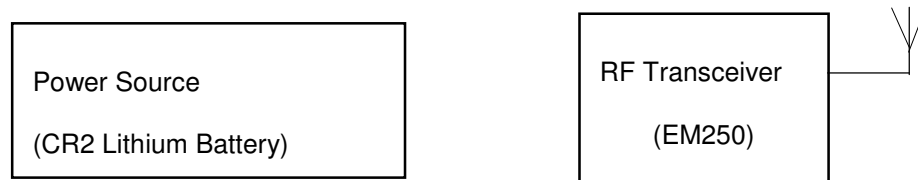
The LifeTag system utilises a 802.15.4 wireless interface and operates in the 2.4GHz International ISM band. The RF communications protocol on which the system communicates is Zigbee. It is not the intention of this document to go into the detail of Zigbee, but to provide the reader with the information necessary to understand how we comply with Spectrum usage.

4 Description of Product

4.1 LifeTag

4.1.1 Block Diagram

The LifeTag block diagram is shown below.



The LifeTag is an internally battery-powered mobile RF Transceiver. The power source is a non-rechargeable Lithium CR2 battery.

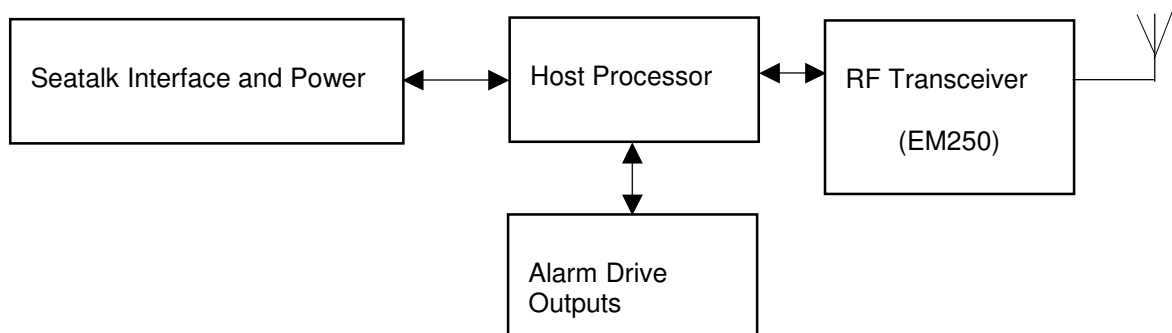
The LifeTag utilises the Ember EM250 RF Transceiver, which runs Ember's Zigbee RF Communications protocol, and the Gigaant Mica internally mounted antenna.

The PCB is laid out in general accordance with the Ember reference design version P3.

4.2 LifeTag Base Station

4.2.1 Block Diagram

The Base Station block diagram is shown below.



The Base Station is powered by and communicates on the Raymarine SeaTalk™ bus.

The LifeTag utilises the Ember EM250 RF Transceiver, which runs Ember's Zigbee RF Communications protocol, and the Gigaant Mica internally mounted antenna.

The PCB is laid out in general accordance with the Ember reference design version P3.

The Base Station consists of the following Functional Blocks:-

4.2.2 RF Transceiver

The RF Transceiver block incorporates a processor that runs the Zigbee RF networking protocol and the interface that communicates with the Host Processor. This interface is called REAP (Raymarine to Ember Application Protocol) which uses a UART running at 19200 bps.

4.2.3 Host Processor

The Host processor provides the interface and protocol conversion between the RF Transceiver (REAP) and the Seataalk Bus.

4.2.4 Seataalk Interface and Power

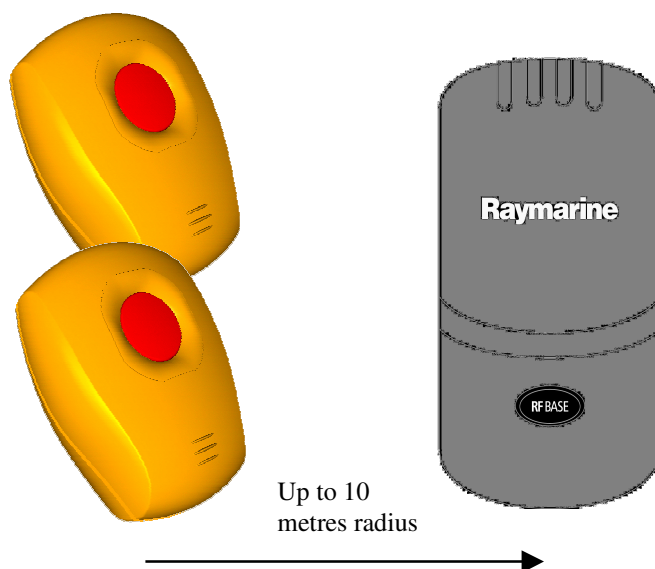
The role of this block is to interact with the SeaTalk™ bus and provide filtering of the power supply. The Base Station operates over a DC Voltage range of 8 – 16V.

5 Description of System

5.1 Single Base Station System

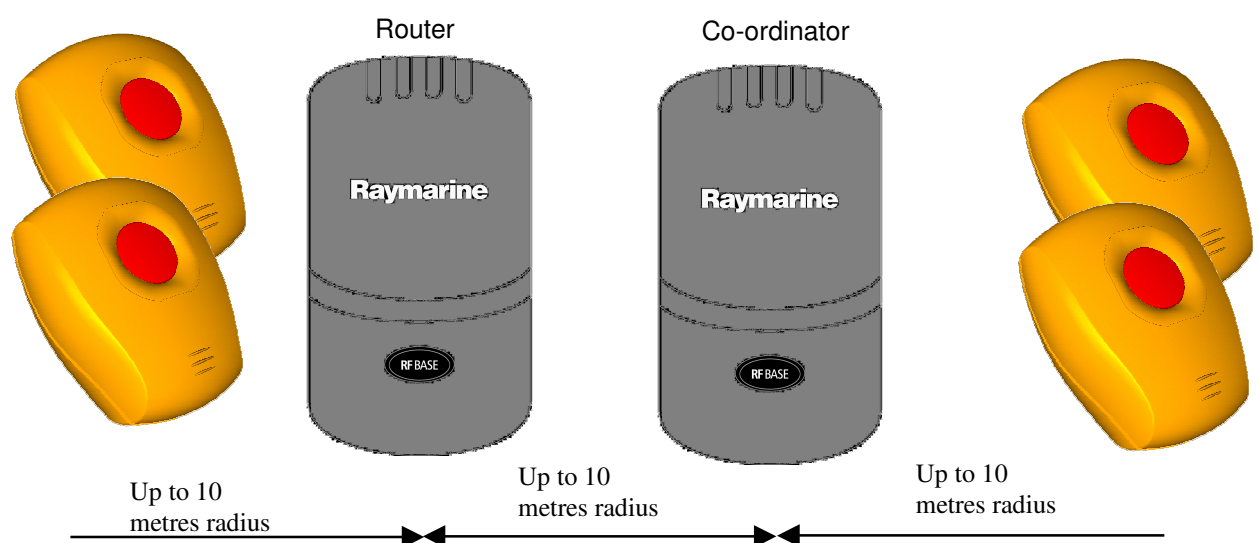
The basic MOB system is sold as two LifeTags and one Base Station (Zigbee Co-ordinator). The System can be enlarged up to a maximum of 16 Tags.

Tags communicate with the Base Station with good reliability up to 10 metres away.



5.2 Extended System

For use on larger vessels, the system may be extended by adding one further Base Station that will act as a Zigbee Router. The overall length of coverage can therefore be extended to up to 30 metres by correct positioning of the Router and Co-ordinator.



6 System Operation Description

6.1 Single Base Station (Co-ordinator) and Multiple tags

6.1.1 Description of Operation

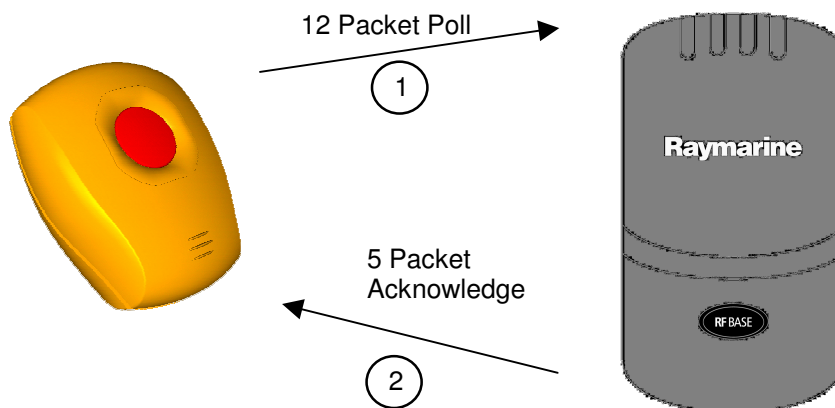
During normal operation, the LifeTag transmits a heartbeat message to the Co-ordinator every two seconds. The method by which the system determines a Man Over Board, or Alarm situation, is either by the Tag going out of range of the Base Station or the button on the Tag being depressed for more than three seconds.

Note that the system is marketed as a product to **aid Man Over Board detection and is not intended to be the sole means of achieving this.**

The Base Station is a static device and is fitted to the boat, normally below decks in a central position. The LifeTag is mobile device that is worn or carried.

The Base Station forms a Zigbee Network with up to 16 Tags. Each Heartbeat received from a Tag resets a 10 second timer. When the 10 seconds expires the Base transmits a special SeaTalk™ message. At the same time, the Buzzer Alarm output and the Auxiliary Alarm Output are driven. As stated above, the alarm condition may also be initiated by depressing the button on the LifeTag.

6.1.2 Normal Operation - Communication Sequence



6.2 Two Base Stations (Co-ordinator and Router)

6.2.1 Description of Operation

The description of operation is the same as for the single Base Station scenario, except as described below.

The Router will normally be used on larger vessels where the range of a single Base Station will not suffice.

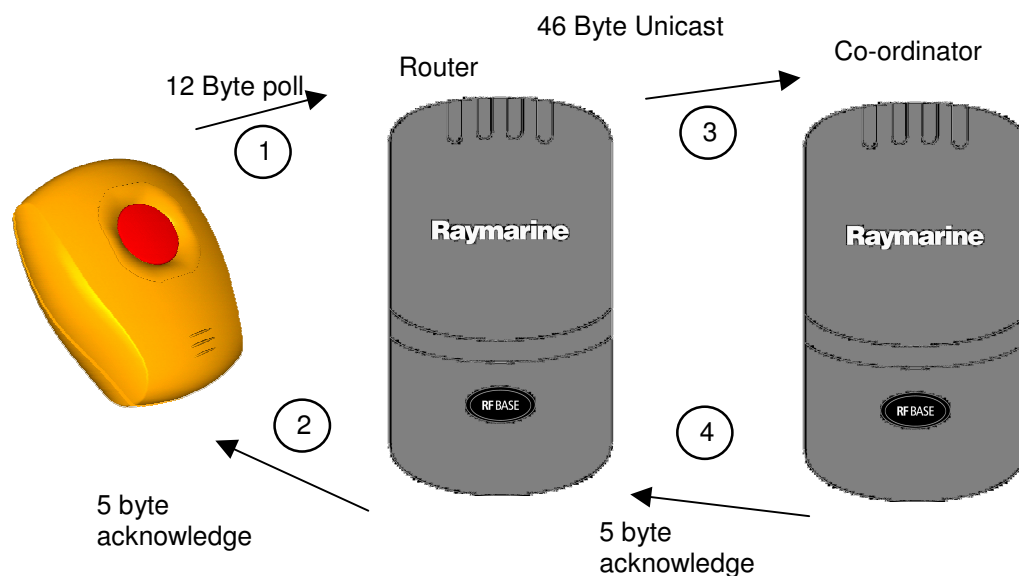
During the power on sequence, one Base Station will assume the role of Co-ordinator and the other the Router. The tag can join the network either through the Co-ordinator or Router. If the Tag joins the network through the Router, then it will continue to communicate with the Network through the Router until it moves out of range of the Router. When the Tag loses 'sight' of the Router it will look for the Co-ordinator to rejoin the network. Conversely, if the Tag is in communication with the Co-ordinator and loses sight of it, it will look for the Router to rejoin the network.

6.2.2 Two Base Stations - Communication Sequence

6.2.2.1 Communication Sequence from Tag to Co-ordinator.

When communicating directly with the Co-ordinator, the communication sequence will be as for a single Base Station above.

6.2.2.2 Communication Sequence from Tag to Co-ordinator through Router



7 RF Implementation

7.1 RF Physical Layer

This physical layer is based upon IEEE 802.15.4. Ember's EM250 IC (www.ember.com) implements this physical layer on which EmberZnet, Ember's Zigbee compliant networking software, operates.

Key Features

- 2405 – 2485 MHz Frequency Range
 - 16 channels @ 5MHz intervals
 - Fixed channel operation – except during high levels of interference on the currently used channel that will result in a search for an RF clear channel.
- Direct Sequence Spread Spectrum
- 0dBm (nom) output power LifeTag
- 2dBm (nom) output power Base Station
- –76dBm (nom) receiver sensitivity LifeTag
- –71dBm (nom) receiver sensitivity Base Station
- Zigbee compliant network

7.2 RF Duty Cycle

The RF Base can support up to 16 Tags. During normal operation each Tag transmits a Zigbee Poll every two seconds and the Base Station responds with a Zigbee Acknowledge. If a Router is used in the system, the Poll from the Tag is relayed to the Co-ordinator with a Unicast. The following Packet sizes apply.

Poll Packet Length	12 Bytes
Acknowledge Packet Length	5 Bytes
Unicast	46 Bytes

7.2.1 Life Tag Duty Cycle

7.2.1.1 Transmission Duty Cycle Characteristics

The Tag Transmits a 12 Byte Poll every two seconds. This equates to a transmission time of 377µSeconds every two seconds.

7.2.1.2 100mSecond Duty Cycle

On average, the time that the tag will be transmitting in any 100mSecond period is 18.85µSeconds.

7.2.1.3 Calculation

The LifeTag transmits a packet every two seconds. The packet length is 12 bytes.

RF Transmission bit rate 255 Kbits/Second

$$Packet_Duration = \frac{(8bits * 12_bytes)}{255KBits / s} = 377\mu Seconds$$

$$Duration_Averaged_to_100mS = 377\mu Seconds * \frac{0.1_Seconds}{2_Seconds}$$

$$Duration_Averaged_to_100mS = 18.85\mu Seconds$$

7.2.2 Co-ordinator Duty Cycle**7.2.2.1 Transmission Duty Cycle Characteristics**

In a maximum system the Co-ordinator transmits a 5 Byte Acknowledge sixteen times every two seconds. This equates to a transmission time of 2.51mSeconds every two seconds.

7.2.2.2 100mSecond Duty Cycle

On average, the time that the Co-ordinator will be transmitting in any 100mSecond period is 0.1255mSeconds.

7.2.2.3 Calculation

The Co-ordinator can support up to 16 LifeTags. The Co-ordinator responds to a LifeTag poll or a Router Unicast with a 5 Byte Acknowledge.

RF Transmission bit rate 255 Kbits/Second

$$Packet_Duration = \frac{(16Tags * 8bits * 5_bytes)}{255KBits / s} = 2.51mSeconds$$

$$Duration_Averaged_to_100mS = 2.51mSeconds * \frac{0.1_Seconds}{2_Seconds}$$

$$Duration_Averaged_to_100mS = 125.5\mu Seconds$$

7.2.3 Router Duty Cycle

7.2.3.1 Transmission Duty Cycle Characteristics

In a maximum system the Router transmits a 5 Byte Acknowledge and a 46 Byte Unicast sixteen times every two seconds. This equates to a transmission time of 25.6mSeconds every two seconds.

7.2.3.2 100mSecond Duty Cycle

On average, the time that the tag will be transmitting in any 100mSecond period is 1.28 mSeconds.

7.2.3.3 Calculation

The Router can support up to 16 LifeTags. The Router responds to a LifeTag poll with a 5 Byte Acknowledge and then sends a 46 Byte Unicast Message to the Co-ordinator.

RF Transmission bit rate 255 Kbits/Second

$$Packet_Duration = \frac{(16Tags * 8bits * (46 + 5)bytes)}{255KBits / s} = 25.6mSeconds$$

$$Duration_Averaged_to_100mS = 25.6mSeconds * \frac{0.1_Seconds}{2_Seconds}$$

$$Duration_Averaged_to_100mS = 1.28mSeconds$$

7.3 Antennas

7.3.1 LifeTag

- Type Gigaant Mica Surface Mount
- Peak gain 2.4dBi typical

7.3.2 Base Station

- Type Gigaant Mica Surface Mount
- Peak gain 4.1dBi typical

8 Technical Summary

Product Name	LT Base Station Coordinator/Router	LifeTag
Part #	A18130	E15026
Schematic Reference	4629-003 Issue C	4629-001 Issue D
PCB Reference	3015-395 Issue D	3015-394 Issue C
Assembly Drawing Reference	4629-009 A	4629-008 A
Output Power	Nominally 1.584mW (2dBm)	Nominally 1mW (0dBm)
Frequency	ANY CHANNEL 16 CHANNELS FROM 2405MHz TO 2480MHz @ 5MHz INTERVALS	ANY CHANNEL 16 CHANNELS FROM 2405MHz TO 2480MHz @ 5MHz INTERVALS
Bandwidth	2MHz	2MHz
RF Physical Layer	IEEE 802.15.4 CSMA-CA	IEEE 802.15.4 CSMA-CA
RF Communications Protocol	Zigbee	Zigbee
Modulation	DSSS FIXED CHANNEL NO CHANNEL HOPPING	DSSS FIXED CHANNEL NO CHANNEL HOPPING
100mSecond Duty Cycle	Co-ordinator – 0.125mSeconds Router - 1.28mSeconds	0.019mSeconds
Antenna	Gigaant Picea	Gigaant Mica
Antenna Gain	4.1dBi typical	2.4dBi Typical
Power Source	EXTERNAL POWER SOURCE (SHIPS BATTERY)	INTERNAL LITHIUM DISPOSABLE BATTERY (CR2)
Default Channel	Channel 0	Channel 0
Receiver Sensitivity	-71dBm	-76dBm
Power Supply	8V – 16V DC	CR2 Lithium Primary Cell