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Mesh Networked Alarm Control System

These simple application boards constitute a bidirectional Mesh networked remote control system. Each board has 1-input, 1-output, a 4-bit global address and a 4-bit Unit ID (hence "M1144"). A complete system consists of a master board (which initiates communication burst cycles) and up to 15 slave units. Any input activation on any slave (or the master) closes the relays on all units on the system. This makes the M1144 an ideal platform for an alarm system.

Figure 1: M1144 application boards

Features

- 4-bit Global address, 4-bit Slave Unit ID selectable via 8-way DIP switch
- 1 Master, 15 Slave Units per site
- Unlimited number of drone receiver/decoders
- Usable with any BiM footprint radios (up to 100mW) with a switching & settling time of <10ms
- 5VDC 44mA or 12VDC 18mA relay to control devices rated up to 8A 250VAC or 5A 30VDC
- Alarm response time <1s to 16s (worst case for whole network)
- Frame synchronisation codes, check sums and address are used to prevent false triggering
- 3.6kbps bi-phase data packet encodes the alarm status and presence of each slave unit on the network
- 1.65% (132ms in 8s) Transmit Duty Cycle per slave unit
- 8.8% (704ms in 8s) Maximum Radio Channel Occupancy per system
- Visual LED indication of communication status and relay state
- 4-times greater operating radius compared to a point-to-point system, using the same radio module
- Logic or Switch input for momentary control of relay
- 3.5mA average current (e.g. 34 weeks operating life from 6xD cells)
- Simple “plug-and-play” setup. No complex programming needed

Applications

- Security and Alarm systems
- Emergency assistance call system
- Status reporting and monitoring systems
- RF Remote control systems
- Industrial controls

Kit Contents

The M1144 Application kit is supplied with the following contents:

1 M1144 Encoder/Decoder Master board
1 M1144 Encoder/Decoder Slave board
2 Radiometrix Transceiver module *(ordered separately)*
2 1/4-wavelength UHF monopole or VHF helical antennas depending on module frequency

Additional requirement

- External DC power supply

M1144 controller and application board

M1144 allows a network which is star based but 4-hops in all directions to enable a network which is 4 times as large as a standard simple star network. The boards are the same for both master and slave, it is just the M1444 firmware which is different for a master or a slave.

Common features and characteristics of the M1144 boards

Interfaces	
Relay Output (RLA1) JP1	8A 250VAC rated SPDT change-over relay (5V or 12V coils to order) 3.81mm pitch 3-way 2 part "Phoenix" type terminal (COM NC NO)
JP5	Open Drain switch instead of relay (optional)
JP7	4 pin ancillary connector (+5V, AUX1, AUX2, GND)
Input JP2	Active low logic input. Pull-up to 5V, and protection diodes provided 3.81mm pitch 2-way 2 part "Phoenix" type terminal): Compatible with Normally Open (NO) Volt-Free Closing Contact
JP4	No Jumper – Default OD28 binary serial output mode Jumper fitted - ASCII diagnostic stream
JP4A	Unused
S1	8-way DIP Switches Bits 7-4 Global Address Bits 3-0 Sending Unit Local ID
Power JP3	12VDC and 5VDC versions available 3.81mm pitch 2 way 2 part "Phoenix" type terminal 40mA peak (plus 18mA/44mA relay coil current if activated) 3.5mA average current (relay off, using 10mW BiM1-173.225-10)
RF	Right-angled SMA or MCX socket (or optional terminal block)
Indicators	
D1	Relay state Red LED
D2, D3	Communication Link Status Red LEDs
M1144 control chip	
28-pin PIC16F883-I/SP	Clock 10MHz (ceramic resonator)
	Timer 1 32.768kHz watch crystal
	Data rate 3.6kbps Biphase coded burst
	Addressing User selectable 4-bit Global Address User selectable 4-bit Sending Unit Local ID
	Response time <1s to 16s (worst case for whole network)
Extreme current saving measures	Switchable pull-ups on DIP switch Very low quiescent current 5V 100mA/250mA LDO linear regulator
Size	
	76 x 63 x 16mm (excluding connectors)
	(four 3.3mm diameter mounting holes are provided)
Operating temperature	
	-20ºC to +70ºC (some radios may be limited to -10ºC to +55ºC)
	(Storage -30ºC to +70ºC)
Radio modules	
	Compatible BiM pinout transceiver 10mW BiM1-173.225-10 (UK) 100mW BiM1-151.300-10 (Australia) 10mW NiM2B-434.650-10 (EU) 25mW NiM2B-458.700-10-25mW (UK) 5mW BiM3G-869.85-10 (EU)
	Not compatible with RDL2 or 500mW BiM3H or BiM1H due to 10ms preamble transmission and regulator current limitations

LED Indications

Master LEDs	In Lock	No Comms
D1 (bottom)	Relay Activated	
D2 (left)	Short Blink	OFF
D3 (right)	Regular Long Blink	Regular Blink

Slave LEDs	In Lock	No Comms
D1 (bottom)	Relay Activated	
D2 (left)	Short Blinks	OFF
D3 (right)	Various Blinks	Constant ON

Drone LEDs	In Lock	No Comms
D1 (bottom)	Relay Activated	
D2 (left)	Very Short Blink	OFF
D3 (right)	Long ON/OFF Cycle	Constant ON

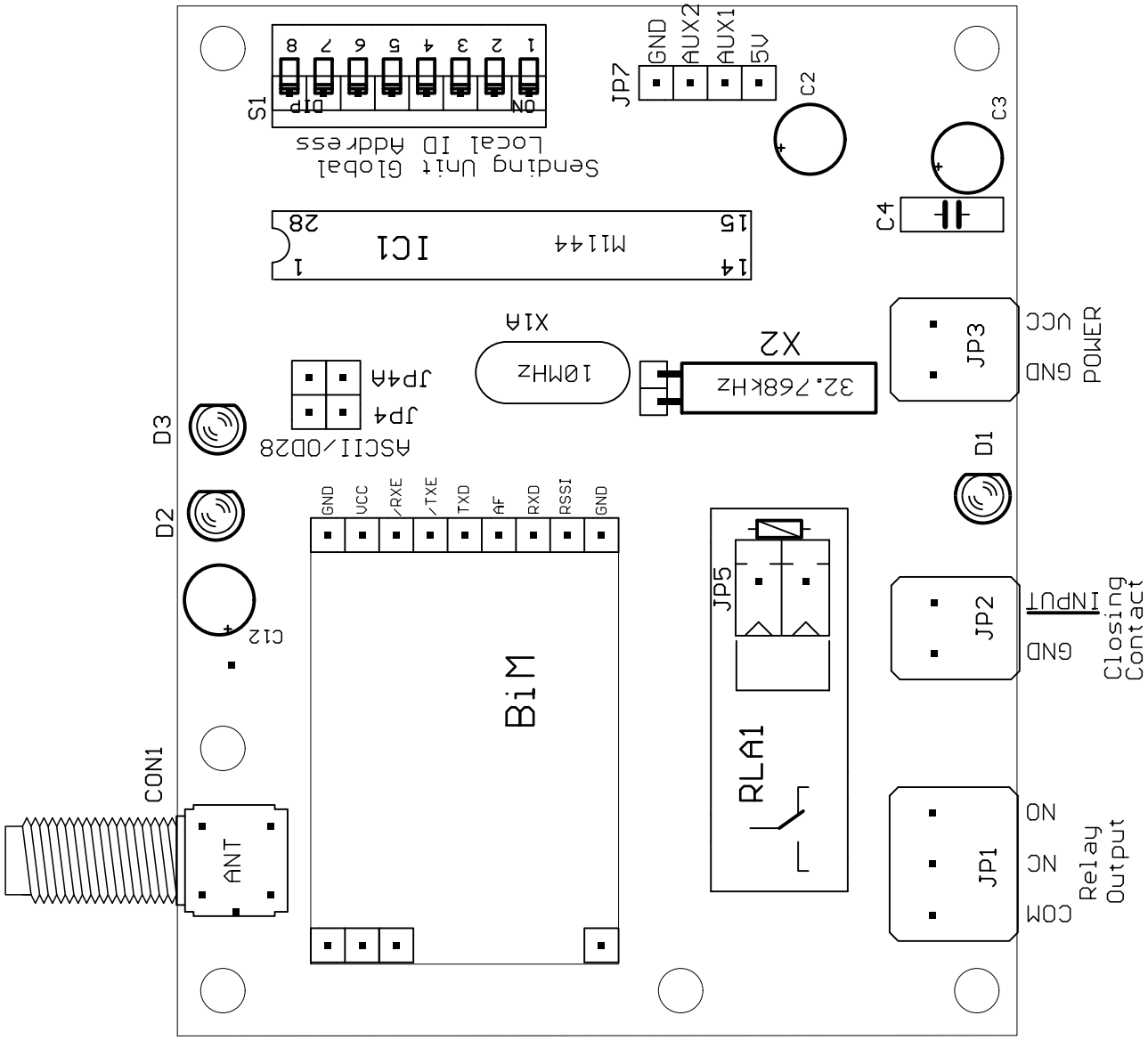

Figure 2: M1144 Board Component Layout

Operational Description

In an M1144 system, timing is everything. Data is only transmitted in carefully defined and synchronised timing "slots". The primary reference for this timing is generated by the Master unit, and is received (and re-sent) by the slave units to provide a consistent time reference across the whole network. A slave unit without valid synchronisation cannot transmit.

The diagram (below) shows how the system timings are arranged.

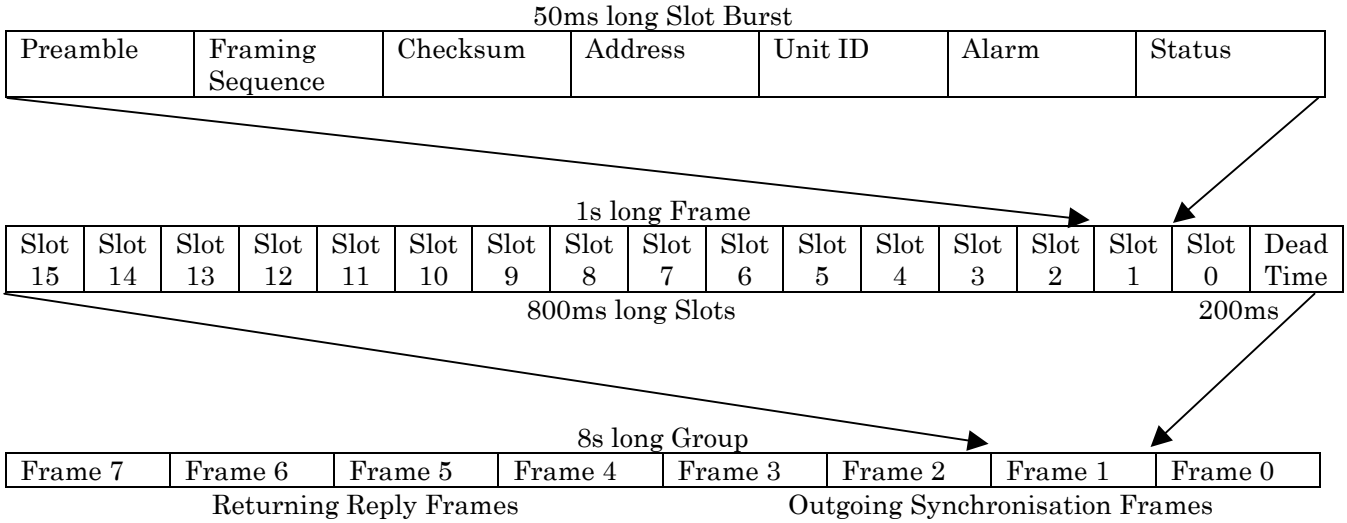

Figure 3: M1144 Synchronised data burst slots of each slave and frame transmission in a group

The basic timing element is a 50ms "slot" (into which a single transmission packet fits, with some margin for error). 16 slots (and 200ms of inactive dead-time) make an 800ms frame. Each slot in a frame is assigned to a specific slave unit ID number. A unit can only ever transmit in its assigned slot. (slot zero is never used)

Eight frames make up an 8 second group, although it is easier to consider the first four "synchronisation" frames and the second four "reply" frames as almost separate things.

Imagine a system starting from "cold":

In the first frame (zero), the master sends out a synchronising message. This sets the timing "clock" for all slaves in range (these units we refer to as "zone 1 units". In frame one, all these units re-transmit a sync message. Units receiving any of these frame 1 messages, but out of range of the master, are the "zone 2" units

In frame two, the zone two units transmit, and are heard by units further out (out of rnage of both master and zone 1 slaves), which constitute zone three. Finally, in frame three the zone three slaves themselves transmit, to the furthest distant units, in zone four.

Zone four units do not transmit a sync message. They wait until frame four and transmit the first generation of "reply" messages, which are received by the zone three slaves. In frame five, these units transmit their reply message to zone two, which then transmit to zone 1 in frame six, and finally in frame seven the zone 1 units transmit to the master.

In this way, you can see that transmitted data radiates outwards (like the ripples in a pond) in frames 0-3, and "bounces back" inwards in frames 4-7.

Reply message bursts carry alarm, and "unit present on system" information from the network back to the master. On re-sending a reply burst, each slave unit adds its own information to the message

Synchronisation messages carry timing information out through the network, but also contain the sum of all the network alarm and status information as received by the master in the previous frame. This is critically important, as the previous-frame network data contained in the synchronising messages allows every unit (slave, drone or master) to act on any alarm input, and allows every unit to output the same serial data on its auxiliary port

ML1144 timings and battery consumption

The battery consumption is very important in this system and the synchronising system used allows the units to maximise battery life. For example, take the worst case, zone 2 or 3 radio, identity number 15.

Idle current is approximately 100µA
at 4.65 seconds in every 8 second group = 0.06mA contribution

TX contribution: 750ms at 2.4mA (processing)
44ms TX actually ON, at 29mA
three times over = 1.197mA
RX contribution: 850ms at 9mA (main listen)
100ms at 12mA (sync listen, LED on)
= 2.36mA

In worst case sync (receiving a sync from a zone 2 unit with slave ID of 14) the sync listen contribution alone rises by 0.9mA, giving us 3.26mA total current.
So an average current would be around 3.5mA.
3.5mA on 20Ah Alkaline battery (6 x D) will last 5700 hours: which is 34 weeks (**over eight months**)
(A PP3 battery will run the unit for a week)

Response time

Alarm "on" activation is faster than "alarm off" (for obvious safety reasons).
Whenever a unit receives either a sync or reply message with any alarm state bit set, it will enter the "alarm on" state and activate its relay. This means that when a unit is activated, the closest units to it (the ones in range) will go into alarm mode as soon as they receive its transmitted message. This will occur within one group, and possibly within the same frame if the activation precedes the unit's slot. This is the fastest possible response time for the system. Generally the worst case should be considered: the time for a unit in zone 4 to alarm in response to the activation of another zone 4 unit, on the "other side" of the network.

In this case, the data bit must propagate in to the master (4 frames) and out again (4 frames): 8 seconds, but to this we must add the even worse situation, that the activation occurs just after the unit's assigned slot: in this case a whole group will tick past before the activated unit will get to transmit its "new" data ... so 16 seconds will elapse.

Setting

These units are supplied in "slave" and "master" varieties.
To maximise operating area, the master should be located in the middle of the site.

The high order 4 DIP switch bits are the 4 bit global (site) address. This must be the same on all units in a system.
Each unit on system must have a unique number.
The local ID on a master should be set at 0000
Local Slave ID numbers (low order DIP switch) must be set between 1 and 15.

Local ID of zero on a slave unit is a special case, turning the unit into a "drone"
A drone listens but does not send data. This is useful where you want to have an indicator only like a siren but no push button alert. It is also useful if you use the AUX1 serial output pin to look at the data on the system. If the data is fed into a board which contains an OD28 output decoder chip it allows the user to display LED indicators of which unit has activated. The OD28 ICs can be purchased separately to enhance the system.

Serial link

A serial link via JP7 AUX1 is provided which has two modes:

1) If the JP4 jumper link nearest the radio module is fitted, the DataStream is a human-readable ASCII diagnostic stream of 1s and 0s indicating status of the system and each cycle outputs effectively the message which is being sent to the system from the master

2) If jumper is removed a special OD28 binary stream is sent every cycle and therefore is used by

systems with the OD28 board for indication purposes. The OD28 allows the user to see units present and alarm states in the form of LED indicators.

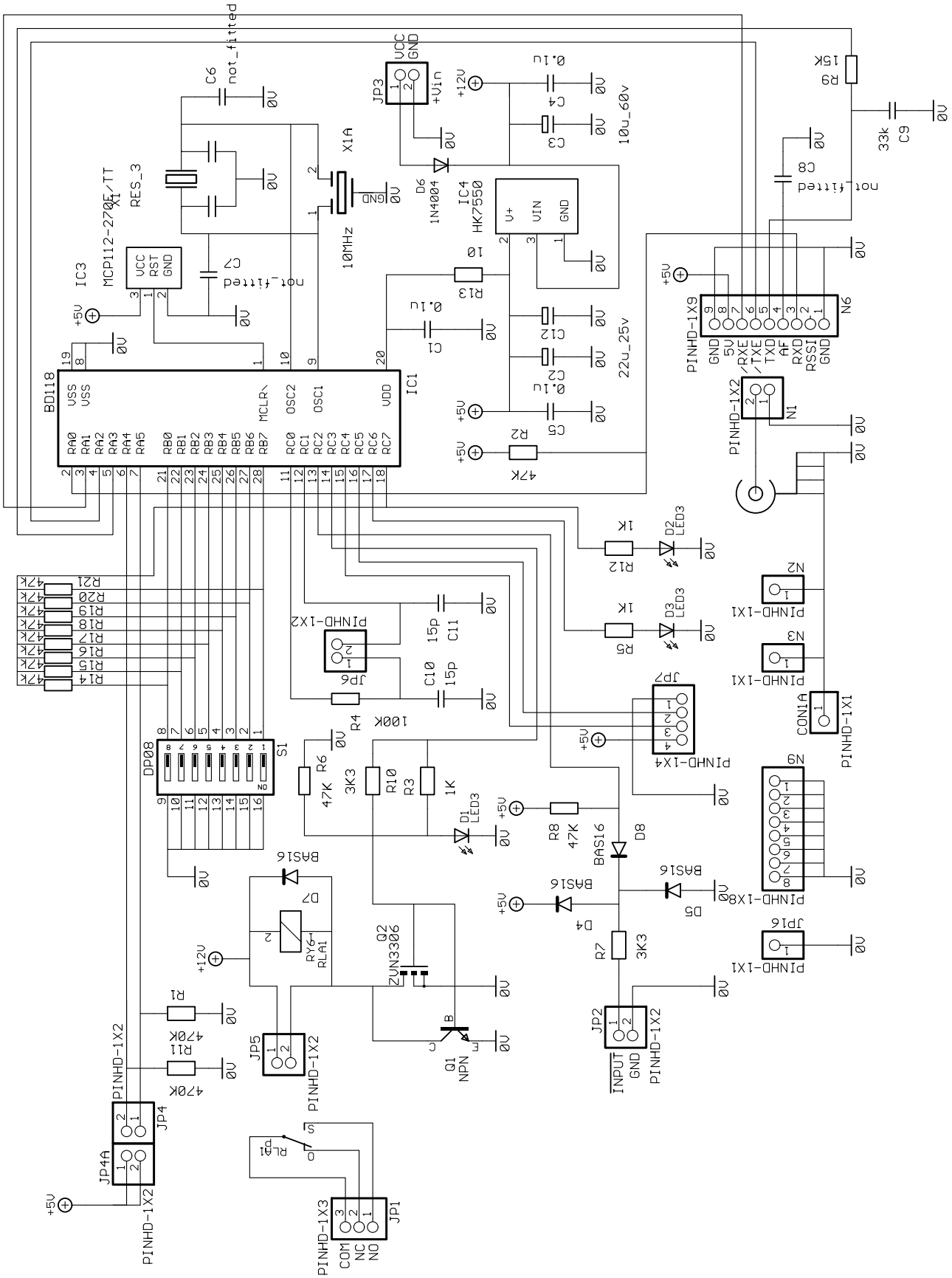

Figure 5: M1144 Application Board Schematics

Ordering Information

Part No.	Version	Frequency (MHz)
M1144-173.225-BiM1-M	Master control board	173.225
M1144-173.225-BiM1-S	Slave control board	173.225
Other VHF frequency variants can be supplied if required.		
M1144-434.650-NiM2B-M	Master control board	434.650
M1144-434.650-NIM2B-S	Slave control board	434.650
M1144-458.700-NiM2B-M-25mW	Master control board	458.700
M1144-458.700-NIM2B-S-25mW	Slave control board	458.700
Other UHF frequency variants can be supplied if required.		

Note: For details relating to the radio module fitted on board, see relevant data sheet
http://www.radiometrix.com/files/additional/bim1.pdf
http://www.radiometrix.com/files/additional/nim2b.pdf

Frequencies and options

The mater and slave units can take any of the Radiometrix 10mW-100mW VHF/UHF transceiver units which have a BiM footprint and switching and settling time of less than 10ms, thereby offering a number of frequency and power options.

Call sales on +44 20 8909 9595 to see what frequencies and power levels are available in your country.

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The Intrastat commodity code for all our modules is: 8542 6000

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 The Office of Communications (Ofcom) web site:
http://stakeholders.ofcom.org.uk/spectrum/technical/rtte/

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