

# Radiometrix Ltd

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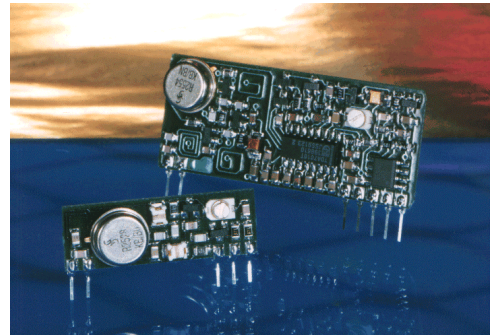
SILRX-UHF

## UHF Radio Telemetry Receiver Module

**UK version:** SILRX-418-5 / SILRX-418-10

**Euro version:** SILRX-433-5 / SILRX-433-10

*The SILRX-418-5 and SILRX-433-5 integrate a complete FM superhet UHF radio receiver on a small module. Together with the matching TXM-418-5 or TXM-433-5 transmitter a one-way radio data link can be achieved over a distance upto 200 metres on open ground*



*left: TXM-418-5 transmitter right: SILRX-418-5 receiver*

### Typical features include:

- PCB mounting, space saving SIL style
- 418 MHz SAW controlled wide band FM reception
- Selective double conversion superhet
- Sensitive typ. 0.5 $\mu$ V (-113 dBm) for 20 dB S/N
- High data rates, 5kbps and 10kbps
- Analogue and Digital data outputs
- Carrier detect output
- Fast enable time, < 3ms for duty cycle power save use
- Wide supply range, 4.0V to 9.0V
- Low current, 13 mA continuous, 130 $\mu$ A on power save (100:1)
- The SILRX radio receiver and the matching DTI (RA) approved transmitter (TXM-418-5) are self contained, PCB mounting modules capable of transferring analogue or digital data up to a distance of 200m.

The SILRX receiver module is particularly suitable for battery powered portable applications where it's low power requirements and small size are of advantage. It may also be used as a lower cost option to the RXM-418-10 in fixed applications where the higher data rates and signal strength output of the RXM-418-10 are not required.

### Typical applications include:-

Site paging receivers

Line powered telephone auto diallers

Guard patrol/lone worker protection

Mobile panic attack

Battery powered half duplex data networks

Lighting control, Garage door openers

Picture/antique protection alarms

Paging car alarms

Domestic and commercial security

Medical Alert/Nurse Call system

Remote industrial process monitoring

Data transfer through hazardous environments

Fire alarms

Remote control, Access control

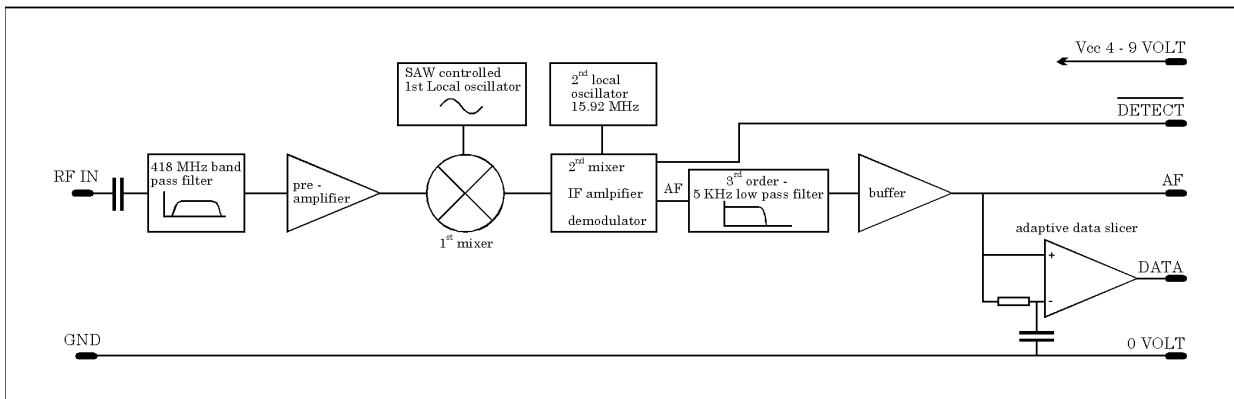
**Brief description**

The SILRX receiver is a double conversion FM superhet with a data slicer driven by the AF output. Additionally a fast acting carrier detect signal is available to indicate to external circuits that a signal is present. This signal is extremely useful when implementing duty cycle power save circuits (see fig 4) or to indicate to external logic that a signal is being received. It is internally derived from the degree of noise quieting due to the presence of a receive carrier.

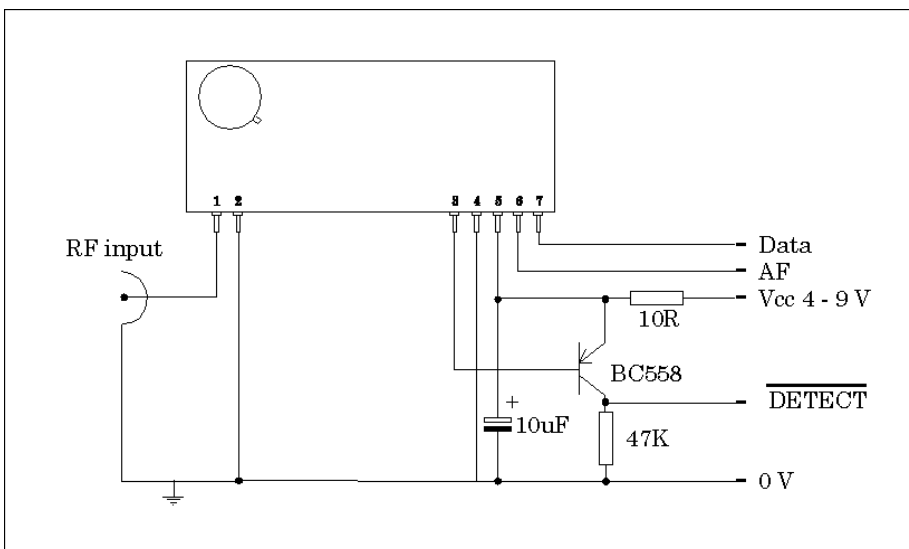
The SILRX-418 is designed to work with the matching transmitter (TXM-418). With the addition of simple antenna the pair may be used to transfer serial data up to 200m. The range of the radio link is very variable and depends upon many factors, principally, the type of antenna employed and the operating environment. The 200m quoted range is a reliable operating distance over open ground using 1/4 whip antenna at both ends of the link at 1.5m above ground. Smaller antenna, interference or obstacles (e.g. building etc.) will reduce the reliable working range (down to 30m in extreme cases). Increased antenna height, slow data or a larger receive antenna will increase the range (our best is 3km).

We recommend that the module evaluation kit, EVAL-418-A, can be used to assess the reliable working range under the anticipated conditions of use.

The following figure shows the receiver's block diagram.



**figure 1: Block diagram**



**figure 2: Test circuit**

## Pin Description

pin	1	RF IN	The receiver antenna connects to this input. It has nominal RF impedance of 50Ω and is capacitively isolated from the internal circuit.
pin	2	RF GROUND	This pin should be connected to any ground plane against which the antenna works. It is internally connected to pin 4.
pin	3	DETECT	This pin may be used to derive a carrier detect to enable external circuits when a signal is being received. If the detect function is not being used a 10 kΩ pull-up to pin 5 (Vcc) should be connected. Refer to applications note for further details on the use of this pin.
pin	4	0 volt	Ground for supply.
pin	5	Vcc	Positive supply of 4V to 9V 13 mA. The supply must be clean (<2mV pp) stable and free of high frequency digital noise. A supply filter is recommended unless the module is driven from it's own regulated supply.
pin	6	AF	This is the FM demodulator output. It has an standing DC bias of approximately 1.4V and may be used to drive analogue data detectors such as modem chips or DTMF decoders. Load impedances as low as 2 kΩ and up to 100 pF can be driven.
pin	7	DATA	This digital output from the internal data slicer is a squared version of the signal on pin 6 (AF) This signal is used to drive external digital decoders, it is true data (i.e. as fed to the transmitters data input). Load impedances as low as 1 kΩ and up to 1 nF can be driven.

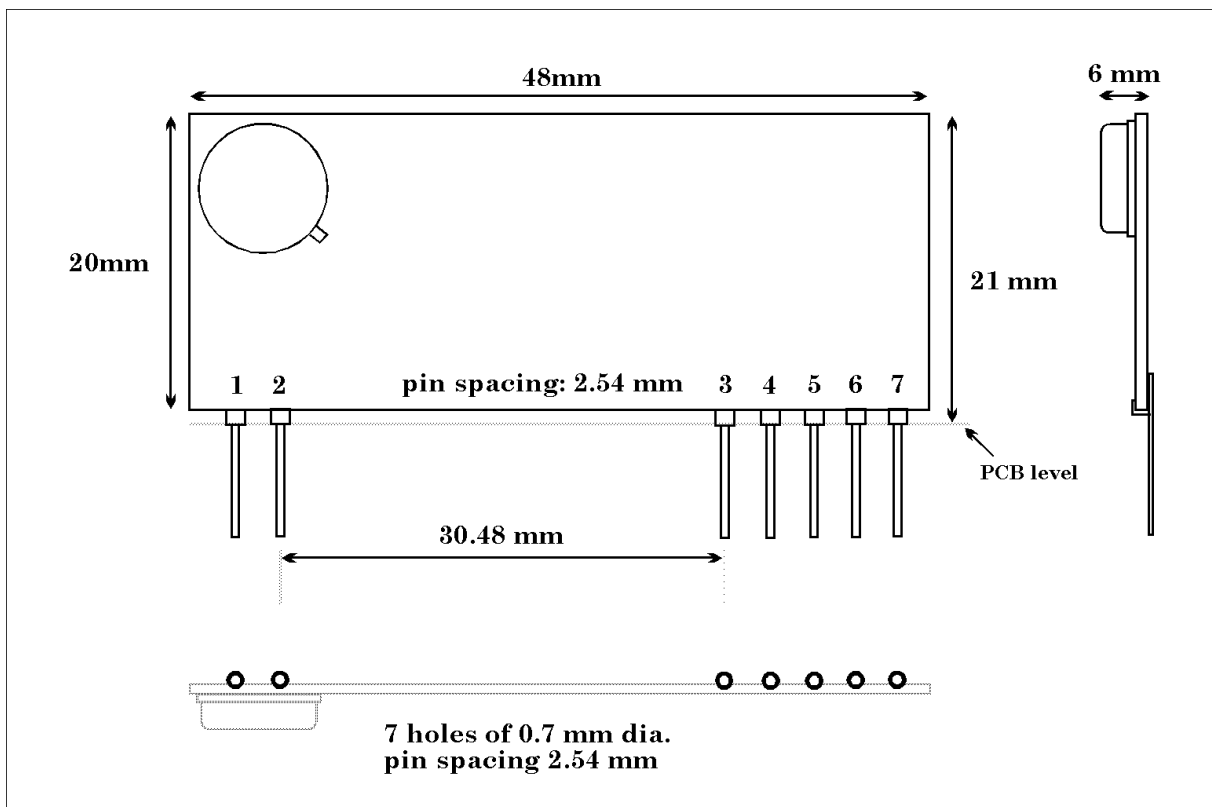


figure 3: Mechanical Dimensions:

## Performance data SILRX-418-5 and SILRX-433-5

ambient temperature: 20°C

supply voltage: + 5 Volt

test circuit: fig. 2

<i>Parameter</i>		<i>Min.</i>	<i>Typical</i>	<i>Max.</i>	<i>Units</i>	<i>Notes</i>
Operating voltage range (V <sub>cc</sub> )	pin 5	4.0	5.0	9.0	V	-
Supply current	pin 5	11	14	17	mA	-
Receive frequency		-	418.00 / 433.92	-	MHz	-
Overall frequency accuracy		- 100	0	+ 100	kHz	1
Sensitivity for 20 dB S/N	pin 1	-	0.5	1.0	μV	2
Carrier detect, threshold	pin 1	-	0.5	2.0	μV	-
RF input impedance	pin 1	-	50	-	Ω	-
IF bandwidth		-	250	-	kHz	3
AF output level	pin 6	-	500	-	mV <sub>pp</sub>	2, 3
AF bandwidth	pin 6	DC	-	5	kHz	3
Frequency/voltage conversion	pin 6	-	10	-	mV/kHz	-
Data output, Logic low	pin 7	0	0.2	0.8	V	4
Logic high	pin 7	4.0	4.5	5	V	5
Data bit duration		0.2	-	20	ms	6
Data Mark:Space		20 %	-	80 %		7
Data settling time	pin 7	-	-	15	ms	8
(minimum preamble duration)						
Enable time	pin 3	-	-	2.5	ms	3, 9
Signal detect time	pin 3	-	-	0.5	ms	3, 9

- Notes:**
1. over supply and temperature range
  2. ±25kHz deviation, 1 kHz tone
  3. 3μV input
  4. 1mA sink
  5. 1mA source
  6. time between transitions
  7. (time high / time low) \* 100 %, averaged over any 20 ms period
  8. time from valid carrier detect to stable data output
  9. from application of supply to carrier detect low (active)
  10. from application of signal to carrier detect low (active)

### Absolute maximum ratings:

Supply voltage V <sub>cc</sub> , pin 5	- 0.3	to	+ 10	V
Operating temperature	- 10°C	to	+ 50°C	
Storage temperature	- 40°C	to	+ 100°C	
RF input, pin 1			0 dBm	
Any input or output pin	- 0.3	to	V <sub>cc</sub> V, ±10 mA	

## Performance data SILRX-418-10 and SILRX-433-10

ambient temperature: 20°C

supply voltage: +5V

test circuit: fig. 2

<i>Parameter</i>		<i>Min.</i>	<i>Typical</i>	<i>Max.</i>	<i>Units</i>	<i>Notes</i>
Operating voltage range (Vcc)	pin 5	4.0	5.0	9.0	V	-
Supply current	pin 5	11	14	17	mA	-
Receive frequency		-	418.00 / 433.92	-	MHz	-
Overall frequency accuracy		- 100	0	+ 100	kHz	1
Sensitivity for 20 dB S/N	pin 1	-	1.0	2.0	μV	2
Carrier detect, threshold	pin 1	-	2.0	4.0	μV	-
RF input impedance	pin 1	-	50	-	Ω	-
IF bandwidth		-	250	-	kHz	3
AF output level	pin 6	-	500	-	mV <sub>pp</sub>	2, 3
AF bandwidth	pin 6	DC	-	20	kHz	3
Frequency/voltage conversion	pin 6	-	10	-	mV/kHz	-
Data output, Logic low	pin 7	0	0.2	0.8	V	4
Logic high	pin 7	4.0	4.5	5	V	5
Data bit duration		0.05	-	2	ms	6
Data Mark:Space		20 %	-	80 %		7
Data settling time (minimum preamble duration)	pin 7	-	-	5	ms	8
Enable time	pin 3	-	-	1	ms	3, 9
Signal detect time	pin 3	-	-	0.3	ms	3, 10

- Notes:**
1. over supply and temperature range
  2. ±25 kHz deviation, 1 kHz tone
  3. 3 μV input
  4. 1mA sink
  5. 1mA source
  6. time between transitions
  7. (time high / time low) \* 100 %, averaged over any 20 ms period
  8. time from valid carrier detect to stable data output
  9. from application of supply to carrier detect low (active)
  10. from application of signal to carrier detect low (active)

### Absolute maximum ratings:

Supply voltage Vcc, pin 5	- 0.3	to	+ 10	V
Operating temperature	- 10°C	to	+ 50°C	
Storage temperature	- 40°C	to	+ 100°C	
RF input, pin 1			0 dBm	
Any input or output pin	- 0.3	to	Vcc V, ±10 mA	

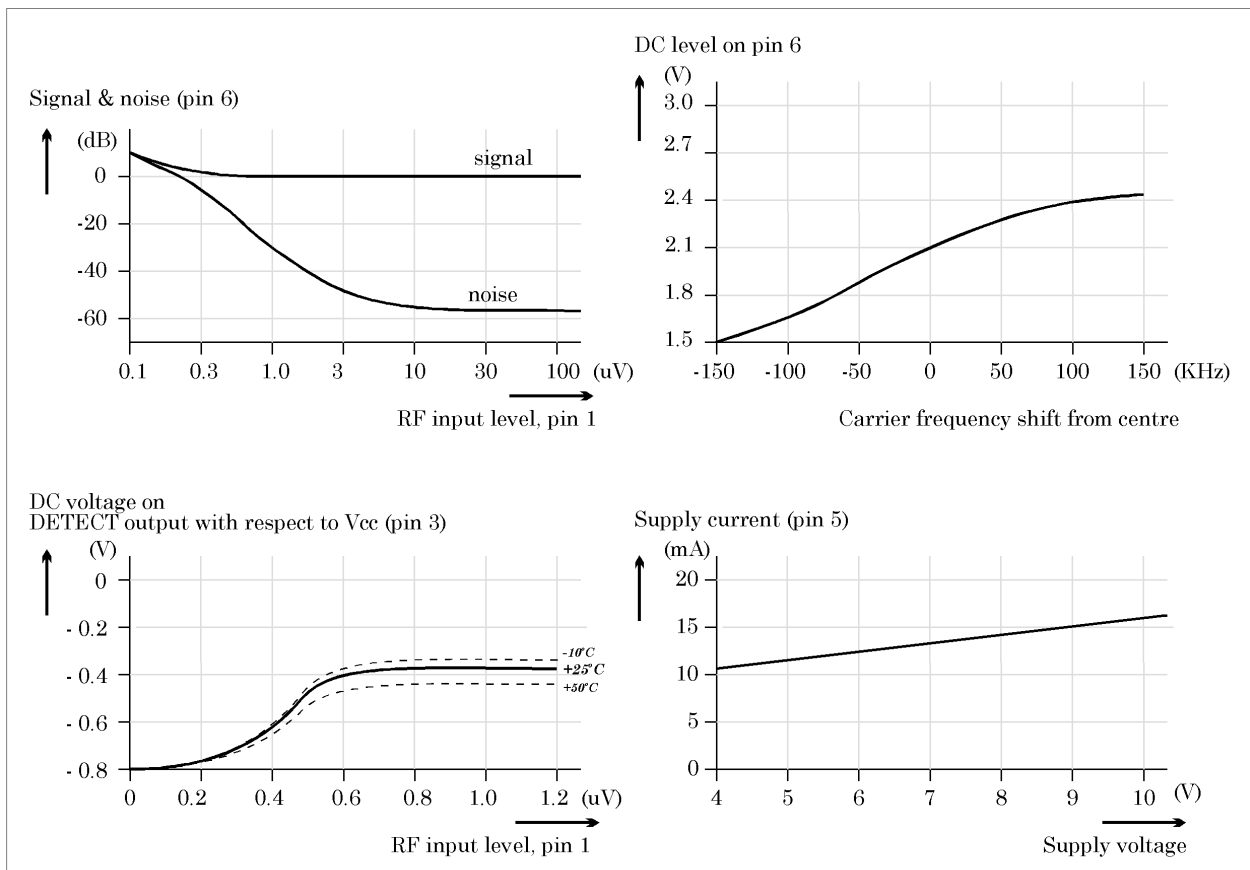


figure 4: Typical performance curves

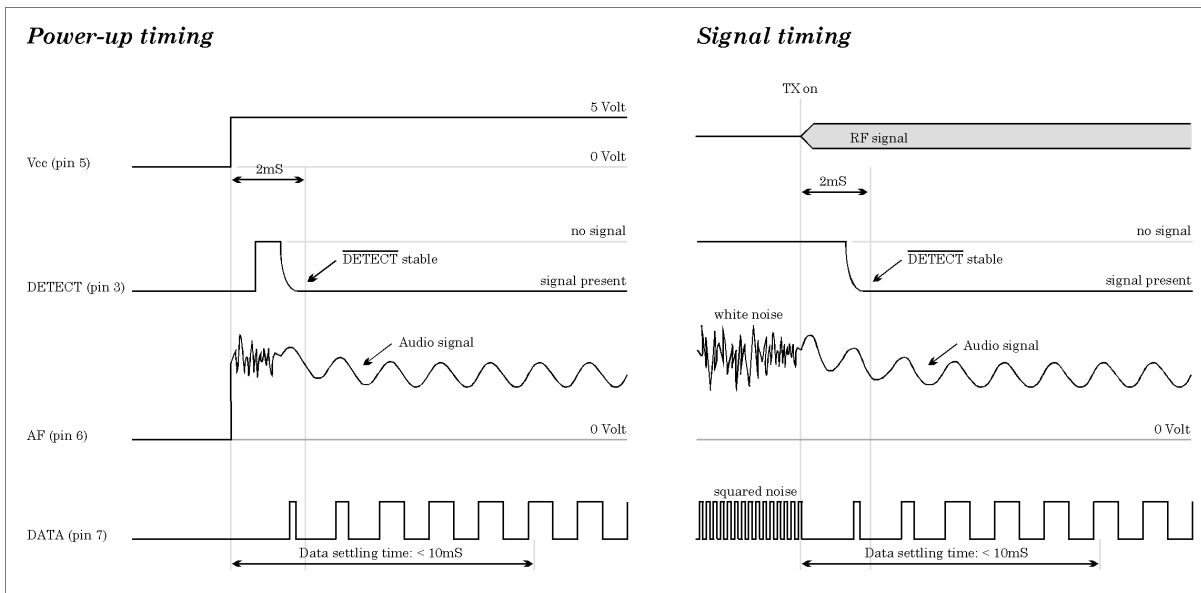


figure 5: Timing wave forms

## Antenna configurations

The positioning of the antenna is of the up most importance and is one of the main factors in determining system range.

The following notes should assist in obtaining optimum performance:-

1. Keep it clear of other metal in the system, particularly the 'hot' (top) end.
2. The best position by far, is sticking out the top of the product. This is often not desirable for practical/ergonomic reasons thus a compromise may need to be reached.
3. If an internal antenna must be used try to keep it away from other metal components, particularly large ones like transformers, batteries and PCB tracks/earth plane. The space around the antenna is as important as the antenna itself.
4. Keep it away from interference sources, bad interference can easily reduce system range by a factor of 5. High speed logic is one of the worst in this respect fast logic edges have harmonics which extend into the UHF band and the PCB tracks radiate these harmonics most efficiently. Single chip microprocessors and ground planed logic boards reduce this problem significantly.

The next diagrams (fig 6) show three different antenna configurations which can be used on both the transmitter and the receiver. Additionally a coax fed external dipole or 1/4 wave ground plane antenna may be considered if system range is paramount.

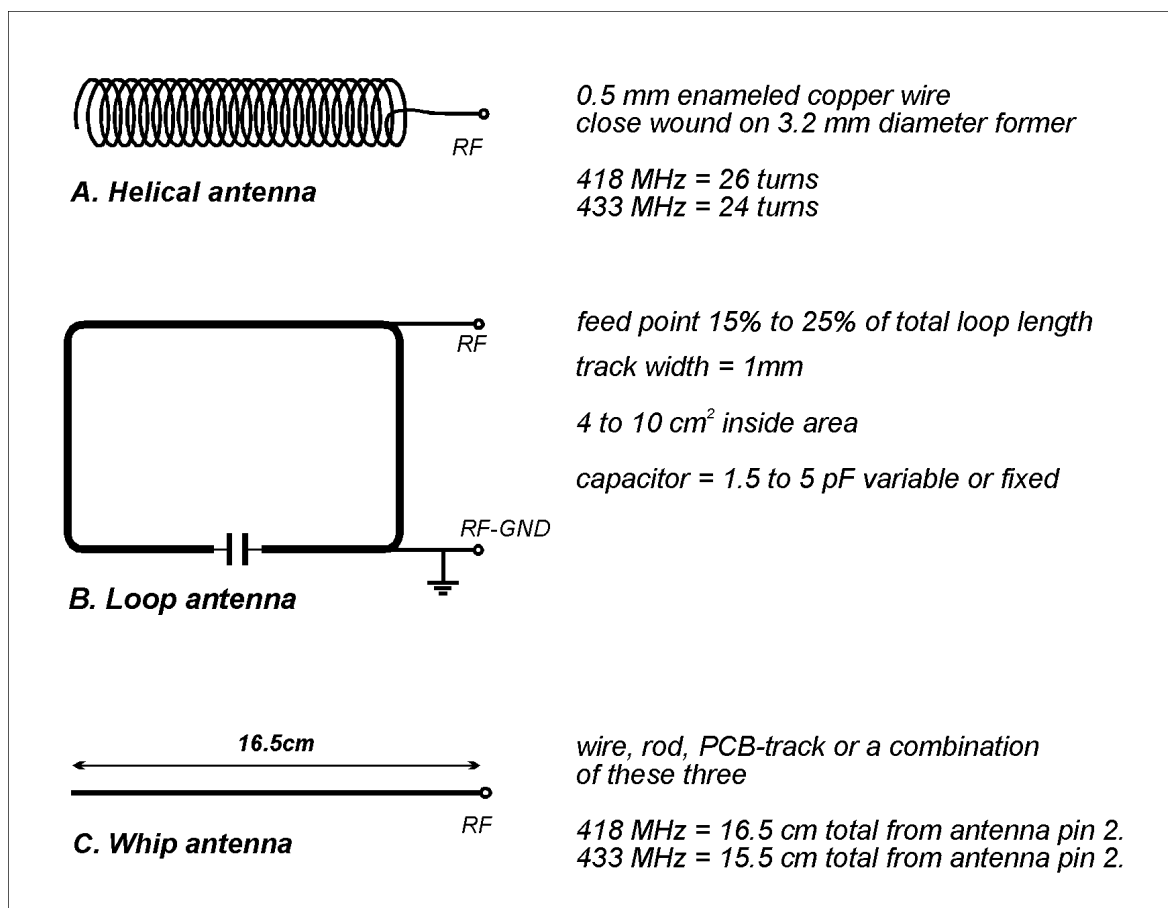


figure 6: Antenna configurations

## Module Mounting considerations

1. The module may be mounted vertically or bent horizontal to the motherboard.
2. No conductive items should be placed within 4 mm of the modules' component side to prevent detuning.
3. Observe RF layout practice between the module and it's antenna i.e. < 10 mm unscreened track, use 50 $\Omega$  microstrip or coax for >10mm
4. It is desirable, but not essential, to earth plane all unused area around the module.
5. Mount as far as possible from high frequency interference sources, Microprocessors with external busses are totally incompatible with sensitive radio receivers and must be keep at least 1 metre from the receive antenna. Single chip micros are not a problem.
6. In some applications it is advantageous to remote the receiver and it's antenna away from the main equipment. This avoids any interference problems and allows flexibility in the sighting of the receive antenna for optimum RF performance.

## Using the DETECT output

Pin 3 of the module may be used in several ways:-

1. Pulled up to pin 5 (Vcc) with a 47 k $\Omega$  resistor unmutes the AF and DATA outputs for normal operation.
2. Pulled down to 0 Volts with a 47 k $\Omega$  mutes the AF and DATA Outputs (both go to 0V).
3. To drive the base of a PNP transistor (see fig 2) to derive a logic compatible carrier detect. The data detect output on pin 3 may be used for duty cycle power saving control in portable equipment where battery life is a problem. By pulsing the receiver on/off the average supply current may often be reduced by a factor of 20 or more depending upon the system requirements the data detect output is valid 1.5 ms (2.5 ms worst case) after application of the supply and is used to inhibit the power saving while data decoding is done.

## Internal data slicer

A CMOS compatible data output is available on pin 7, this output is normally used to drive a digital decoder IC or a microprocessor which is performing the data decoding. The data slicer in the receive module is designed to accept data with a wide range of pulse widths and mark: space ratio's, see specification table for limiting values. The data slicer has a 10 ms transient response time this is the settling time of the adaptive comparator, i.e. the first 10 ms of signal may be corrupt at the data output.

## System coding

The transmit and receive modules have no internal digital coding/decoding thus allowing the flexibility to send many types of data. Encoder and decoder IC's are required to give the system a high degree of protection from false triggers due to noise/interference/neighbouring systems and often for security reasons. There are wide range of suitable encoder/decoder IC's which may be used with the modules, including :-

MM57C200, MM57410, National Semiconductor

UM3750, UMC

HT12 series, Holtek

MC145026 series, Motorola

AS2787, Austria Mikro Systeme International GmbH

Additionally IR. remote control, DTMF, Selcall and modem IC's can be easily interfaced to the modules.



## AF output

This output is the FM demodulator's output after buffering and filtering. Since it is taken before the data slicer in the module, it may be used to drive external data slicers / demodulator's in cases where the internal data slicer is not suitable. This is the case where an analogue subcarrier is being employed e.g. 2 tone AFSK or DTMF tones. In these cases the AF output is used to drive the FSK / DTMF decoder directly.

The AF output is also a very useful test point for monitoring signals or interference. The AF output is DC coupled to the FM demodulator thus the DC level Varies with the frequency of the incoming signal.

## Supply requirements

The module requires a clean supply. Noise and 'hash' in the 5 to 500 kHz band and 16 MHz  $\pm$ 1 MHz must be less than 2 mV, We recommend a 10  $\mu$ F capacitor to ground on pin 5 (Vcc) and a 10 $\Omega$  series feed resistor in cases where the cleanness of the supply is in doubt.

**Warning:**     *Don't be tempted to adjust the trimmer on the module, it controls the receive frequency and can only be correctly set-up with an accurate RF signal generator!*

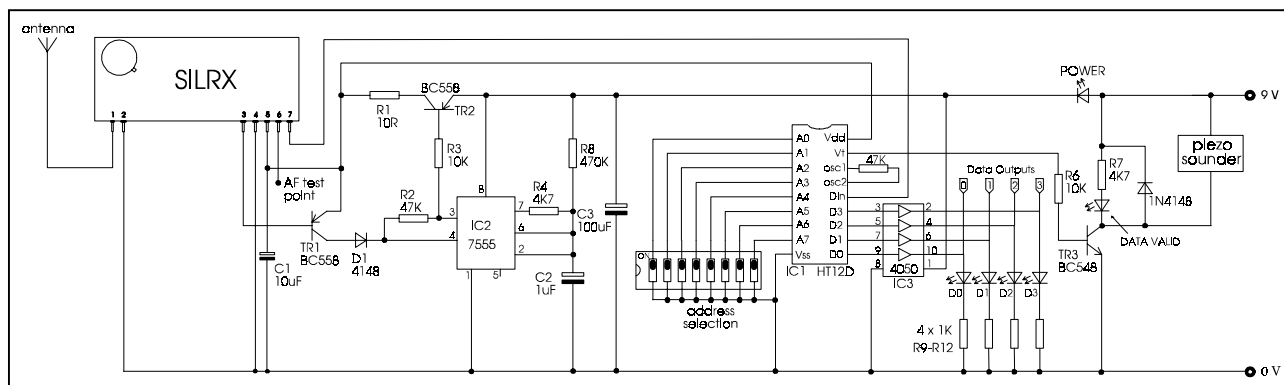
## Additional Reading

BS 0799	British standard for Wire-free intruder alarm systems
BS 4737	British standard for intruder alarm systems in buildings from British standards institution - Tel. 44 171 629 900
MPT1340	DTI type approval specification for 418 MHz Telemetry from department of Trade and Industry - 44 171 211 0502/0505
ARRL Handbook	Excellent radio engineering text
ARRL Antenna Book	Practical antenna design book

## Applications note

### Four Channel Receiver with battery saver

Fig 7 shows a simple four channel paging receiver with 256 setable codes. The CMOS 555 timer provides a duty cycle power save circuit which latches **ON** when a signal is present. The values used in the example give 4ms **ON**; 400 ms **OFF**, i.e. 1:100 duty cycle. The total quiescent current is less than 200 $\mu$ A, thus a 9V alkaline battery (500 mA/hr) will give a life of over 2000 hours. The **ON** time is determined by the receiver's power up settling time (3 ms worst case) + any tolerance of the duty cycle oscillator. The **OFF** time is controlled by **R8** in the circuit and should be selected to suit the application depending upon the required response time and any limits imposed upon the duration of the transmission. It is recommended that the **OFF** time be no longer than 1/2 for the transmission preamble duration.



*figure 7: Four Channel Receiver with power save*

## Ordering information

SAW based OEM Transmit and Receive modules.

TXM-418-5	UK Transmitter on 418 MHz, Type approved to MPT1340
TXM-418-10	Fast transmitter on 418 MHz, Type approved to MPT1340
RXM-418-5	matching UK receiver module on 418 MHz
SILRX-418-5	Low current UK receiver module on 418 MHz
BiM-418-10	Bi-directional short range module on 418 MHz
RPC-418-5	Self-contained module which integrates the BiM transceiver with a Radio Packet Controller
EVAL-418-A	Evaluation kit for TXM & RXM
EVAL-418-B	SILRX supplementary PCB for EVAL-418-A
BiM-KIT	Evaluation kit for BiM-UHF modules.

*All modules are available in a 433.92 MHz version for use in other European countries.*

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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](http://www.radio.gov.uk/document/libind.htm#emc)*

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