EXHIBIT "E"

PRODUCT MANUAL

CENSUS READER

FCC ID: JHD-CEN1

Site Manual

CRYPTAG® CENSUS™
SITE MANUAL

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This manual is provided for information purposes only. All information included in this manual is subject to change without notice. Identec is not responsible for any damages, direct or indirect, arising from or related to the use of this manual, or associated product.

WARNING NOTICE

This product uses radio frequency signals to identify tags, and is therefore subject to possible interference. Any application should bear this in mind, and in particular it should not be possible for personal safety to be jeopardised by a failure to read.

Cryptag Census neither uses nor generates hazardous voltages. You should not connect any such voltage to the reader.

CE

This product complies with the following European Community directives: [1]

Low voltage directive (73/23/EEC)
[2]EMC Directive (89/336/EEC)

[1,2]FCC Regulations

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device must not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Identifier: JHD-CEN1

Note:
Systems that comply with FCC regulations operate at different frequencies, and only such systems are to be installed in USA. These systems have some performance differences (in particular a slight increase in reading speed). Throughout this manual, the effect of the change in frequency is noted, e.g. "131kHz (in USA, 153kHz)". The part numbers of readers and tags for use in USA have an "A" added, e.g. CR1A, TC1A. Any reference in this manual to CR1 also applies to CR1A.

This manual covers the single aerial version (CR1, or in USA CR1A), the dual aerial version (CR1-DS, or in USA CR1A-DS) and the version with a single transmit aerial, and separate single or dual receivers (CR1-DS1, or in USA CR1A-DS1).

[1]For more information on approvals, refer to Appendix E.

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#Software Options

Cryptag Census readers can be supplied with a number of software options, which may affect the reader's response and/or performance. These are marked in the text with "#".

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1. CRYPTAG CENSUS

1.1 Introduction

Cryptag Census has two basic components, the reader and the tags. The reader will identify all Cryptag Census tags within its reading range. (We refer to this as the Reading Zone.) In the simplest form, the reader will report each tag as it is seen, but many other software variants are possible, so that for instance the reader may only report tags belonging to the installation. If you have an application, talk to Identec. It's quite possible that it's already provided for.

Readers are supplied fitted with an internal aerial, but this can be replaced by an external aerial loop or multi-turn coil, for instance, to customise the reading range. It is possible to fit more than one aerial, to give the best possible performance, or to track tags as they pass the reader.

Tags are programmable, but once they have been programmed they cannot be reprogrammed and become "Read Only". Tags contain a small lithium battery, which should normally last many years. Readers can be configured to indicate when the battery of a tag is going low.

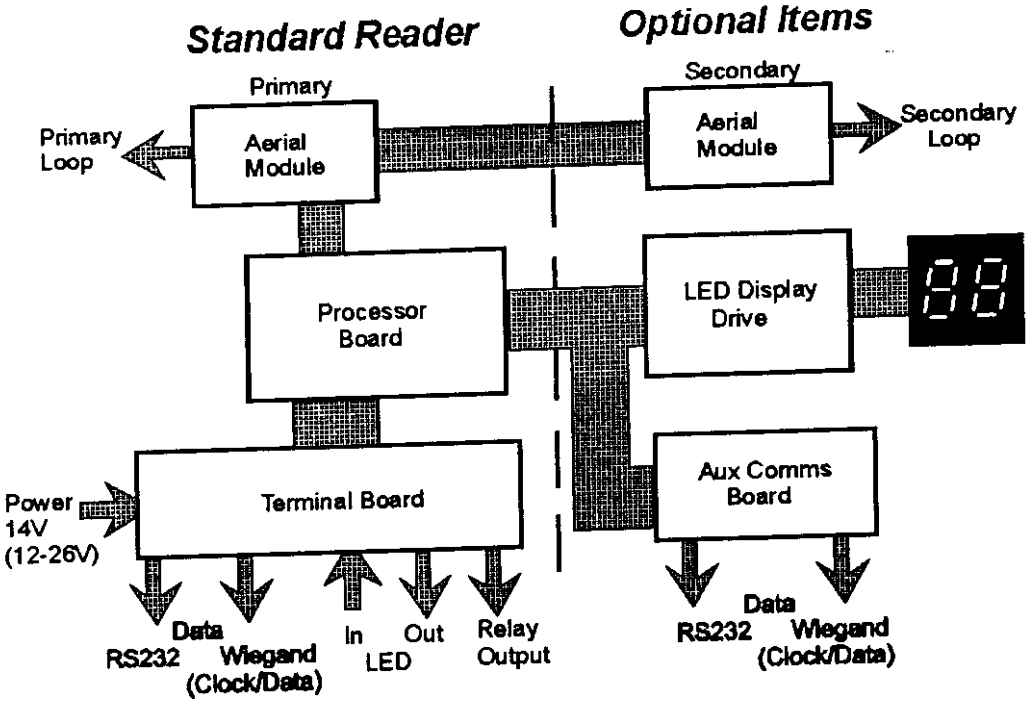
Cryptag Census is an advanced third generation RFID (Radio Frequency Identification) product from Identec Ltd of County Durham, England. It can be used as a standalone product in simple applications (such as opening a single door), or as part of an integrated solution where the output of the Cryptag Census reader is used by other equipment. Cryptag Census combines fast, high integrity, multiple reading of all tags present, good reading range, and ease of installation.

This manual is intended for use by installation and commissioning engineers on site. Most of the information you need to know about installing the reader is available on the Installation Sheet on the inside of the reader's lid. This manual contains some additional background information on Cryptag Census. There is also a more comprehensive Product Reference Manual available, for System Design engineers.

1.2. The reader

A Cryptag Census reader identifies tags (sometimes referred to as tokens or cards) using low frequency radio signals.

Cryptag Census readers use a single aerial coil for transmitting and receiving. The coil is tuned for the transmitter frequency of 131 kHz (in USA 153kHz), using a parallel capacitor. The internal coil is a 2 turn loop around the perimeter of the reader. This can be replaced by an external coil, which will usually be a single loop for anything larger than the reader's internal aerial, although a small mullion aerial can also be fitted.



The basic CR1 reader consists of the Processor Board (the heart of the reader), the Terminal Board (which contains the connections to the outside world), and the Aerial Module (which links up with the aerial loop). The same Aerial Module can be used with either the internal aerial, or an external aerial.

#The CR1 reader can be supplied with several options, to enable it to meet specific requirements. These are usually associated with appropriate software options. For instance:-

- Second Aerial Module. This must be connected to an external aerial.
- Tag Counter Display. An LED display module that shows how many tags are present.
- Auxiliary Communications Board provides a second set of data outputs.

1.3 Tags

Cryptag Census tags are designed for long reading range, and are therefore "active" tags containing a small lithium battery. Batteries will normally last many years.

Tags have a 64 bit identity number, although many applications will use fewer bits. The identity is programmable, but once a tag has been programmed it cannot have its identity altered. Tags never reveal their identity number directly, but it is discovered by the reader after an interrogation dialogue.

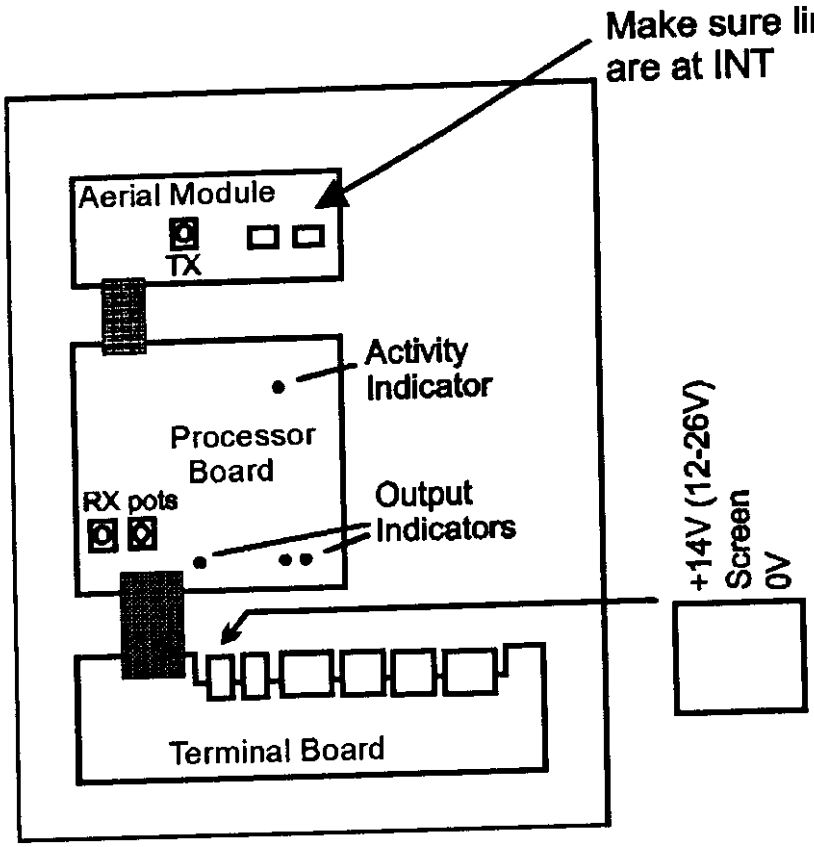
The tags are robustly constructed, and extremely reliable.

#Software options can affect performance.

1.4 Getting started

If you want to see the reader working, just follow these simple instructions.

1. Carefully remove the lid from the reader. Using the 2.5mm screwdriver provided, connect 14V to the power connections. Make sure the polarity is right!



2. Bring a tag near the reader.
With the internal aerial, the reading range should be approximately 1.2 metres (4 feet), when the TX and RX potentiometers are fully clockwise (their factory setting).

3. The Activity Indicator LED will flicker when the tag is within range.
#Most readers report data when the tag first enters the Reading Zone. This is usually shown by the Output Indicator LEDs flashing once. To get the reader to report the tag again, move the tag well away from the reader for several seconds, then bring it back to the reader as in Step 2.

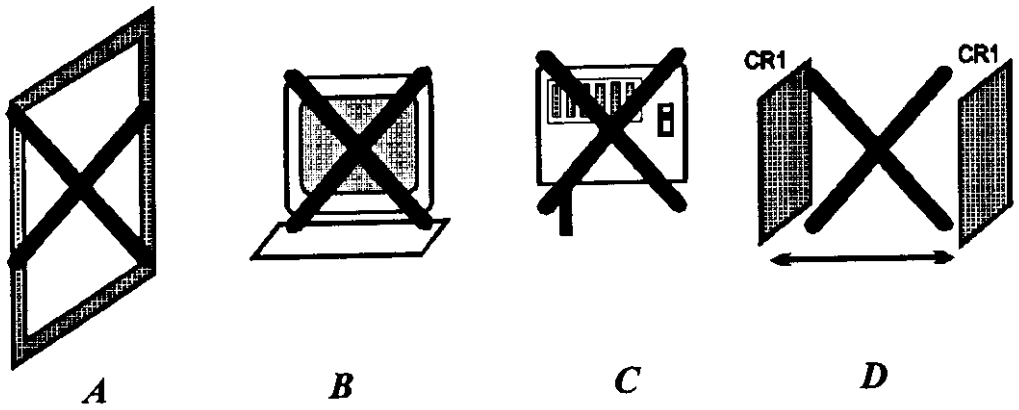
4. You can get the reader to produce test messages.
Press the red button on the Processor Board and hold it down for at least 3 seconds before releasing it. The reader will send test messages on its Wiegand and RS232 outputs. You will see the Output Indicator LEDs come on while the data is sent. Tag data will be reported on both outputs.

#Software options can affect performance.

2. READER LOCATION

2.1 Siting the reader

Appendix B covers the selection of the reader configuration (internal or external aerial, etc.). This section is about where exactly the reader should be positioned. The intended location should have been checked already, but you should confirm that nothing has changed, and if necessary perform another Site Survey (see Section 2.2).



A Do not position aerials less than 200mm (8 inches) from a metal surface, or loop. Any large metal structure may affect performance. See Appendix A.9. *A large metal sheet will reduce reading range behind it, giving some partial screening. See Appendix A.10 for more details.*

B Do not position aerials less than 1.5 times the reading range from a computer monitor, e.g. 4.5 metres (14 ft) from a 2 metre (6ft 6 in) square loop.

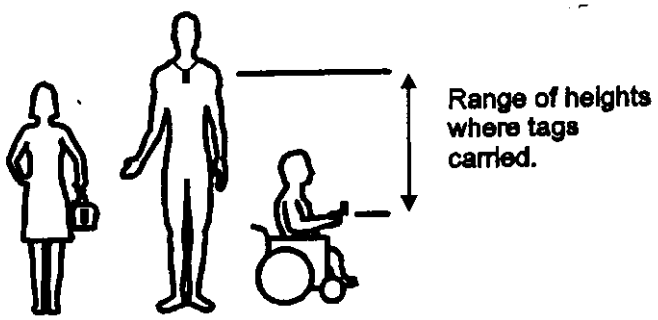
C Do not position aerials less than 1.0 times the reading range from large mains or data cables unless you have **thoroughly** checked them with a Site Survey Meter. If other cables are at 90° to the plane of the loop, they will have less effect.

D Do not position aerials less than 3.0 times the average reading range from another reader's aerial. Think vertically as well as horizontally, as tags can be read through walls, floors and ceilings.

Make sure that the situation isn't going to change after you've installed the reader, particularly on new or refurbished buildings. Is there any other equipment, filing cabinets or cabling to be installed?

A readers with an internal aerial, or an external mullion aerial, should normally be positioned on the wall beside the door. They should be near to the door handle, on the "insecure" side. The location of larger external aerial loops should have been decided already, and will depend on where tags are to be read.

Check that no problems will arise from tags being read behind the reader or to the side. (The reading zone is almost spherical.)



Before positioning the aerials, consider their height from the floor. When tags are being carried by people, the best height should be selected with regard to both the way in which tags will be read, and the visibility of the LEDs.

The best height is generally where tags will naturally be presented face on to the reader. With a hands-free technology, tags are carried at a wide range of heights. (Around the necks of the tallest people, in bags carried by shorter people, and possibly held by users in wheelchairs.) If tags are to be presented to the reader, the reader should be within reach of people in wheelchairs.

If tag holders must be able to see the LEDs, make sure that they will be visible to all users. The CR1 reader provides outputs for additional external LEDs, which may be more suitable.

Finally make sure that the cable runs from the reader, especially to the external aerial, are not too long. The normal maximum cable length from the reader electronics to the external aerial is 10 metres (33 ft), but you are advised to have the electronics as close as possible to the aerial to ease commissioning and subsequent servicing.

If in doubt, ask. Your supplier should be able to give you advice on particular situations.

2.2 Site Survey

The Site Survey is a very important part of the installation. It is the key to a trouble-free installation.

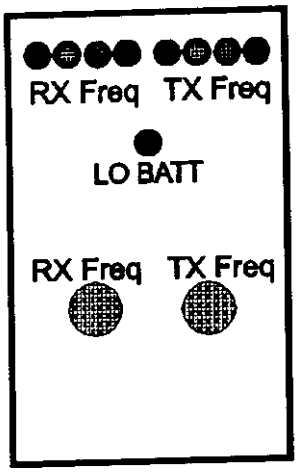
a) First, check again to make sure that there isn't anything that's going to produce interference or affect performance. (All of these justify special attention during a Site Survey.)

Computer screens (VDU or monitor)
Other electronic equipment
Metal structures (e.g. windows, doors, other frameworks)
Partitioning that may be on metal supports
Mains switch boxes or fuse boxes.
Unscreened or badly screened data cables.
Fluorescent lights or low voltage lighting.

b) Make sure you have a Site Survey Meter MS2 (in USA MS2A). **Type MS1 is not suitable for Cryptag Census.**

c) Before you start the survey, make sure all electrical equipment is switched on, and any cables are supplying typical signals.

d)



Note: Units may be marked with the actual frequency.

	Normal (MS2)	USA (MS2A)
RX Freq	98kHz	115kHz
TX Freq	131kHz	153kHz

To survey the site, press the TX Freq button on the MS2, and check that the LEDs stay at green. Move the meter around the whole intended reading zone for this reader location, making sure that you rotate the meter to different orientations. (e.g. at each point do 3 checks, one with the front surface of the meter horizontal, and two with the face vertical).

You should not see the LEDs go from green. If they do change from green, it is probable that tags will not be read **actually in that position.** (This is an important point for the TX Freq test. Tags will not be read at the point in space where the LEDs ceased to show green.)

e) Repeat the test with the RX Freq button pressed. **Interference is much more likely to affect the RX Freq transmissions, so more care is needed on this test.**

The RX Freq test need only be done with the MS2 in the same orientation as the intended aerial loop. The form of the test will depend very much on the reading range you are expecting. (Anything other than green means reduced range.)

For a range of up to around 1 metre, it will be sufficient to hold the MS2 at the intended reader location, where the LEDs should stay at green.

For longer range readers, move the MS2 around the intended aerial location, looking for possible sources of interference, and then assess their likely effect, by seeing how close to the reader their influence extends.

f) Find out whether any changes are planned, which may affect the validity of your survey.

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3. INSTALLATION

If this is the first time you have installed a Cryptag Census reader, you should have this manual beside you as you work. When you are more familiar with the reader, you should find all the information you need on the Installation Diagram on the inside of the lid.

3.1 Unpacking

Carefully remove all the equipment from the packaging. Check and inspect for visual damage and check against the delivery note to make sure there are no missing items. If any items are missing or damaged, inform your supplier **immediately.**


Reader


This manual


Screwdriver


Spare fuse (& screws)

Take great care when removing the lid of the reader. Do not handle individual circuit boards without following anti-static precautions.

3.2 Special Tools and Materials

Most of the tools required to install a Cryptag Census reader will be found in a competent electrician's tool box, and in most cases what you need will depend on the particular installation. The only special tool needed is the 2.5mm screwdriver provided with the reader, for use on the terminal blocks.

> **The demountable screw terminals used for external connections to the Cryptag Census CR1 reader can be a little confusing at first. Only use the screwdriver supplied with the reader.**
>
> **Before inserting the wire, always make sure the terminal is open, by turning the screw anti-clockwise for about 5 turns. Then insert the wire, and tighten.**
>
> **The screw is not necessarily electrically connected when the terminal is open. If you probe an open terminal you are likely to get misleading results.**

The reader is normally supplied with the cover secured by 6 cross-headed screws. Some or all of these can be replaced by any M3 security or tamperproof screws. You will need the appropriate security screwdriver if you select such screws (and remember to leave one on site).

3.3 Cabling

You must use screened cable for the connections to the reader, and if applicable for the connections to an external aerial. (Radio approvals require this.) Suitable cable is readily available, or it can be obtained from Identec. Foil screened cable with a drain wire is suitable.

For the multi-core screened cable used to connect to the reader, Identec recommend a 12-core screened cable (e.g 7/0.2mm, 24a.w.g). You may need fewer cores, but any spare cores can be used as additional 0V/14V power connections.

Cable lengths are limited principally by voltage drops in the power lines. Wiegand and Clock/Data outputs can be used up to 100 metres (330 ft). RS232 outputs should not be used for over 10 metres (33 ft). (Unless it has been configured for less than 9600 baud.)

The reader requires between 12V and 26V d.c. power (14V nominal). If there is a long cable run, the voltage drop may be excessive. The reader should not be operated with less than 12V input at the reader terminals. (A buzzer comes on below 11.5V.)

For the cable between the reader electronics and external aerials, refer to Section 3.6.

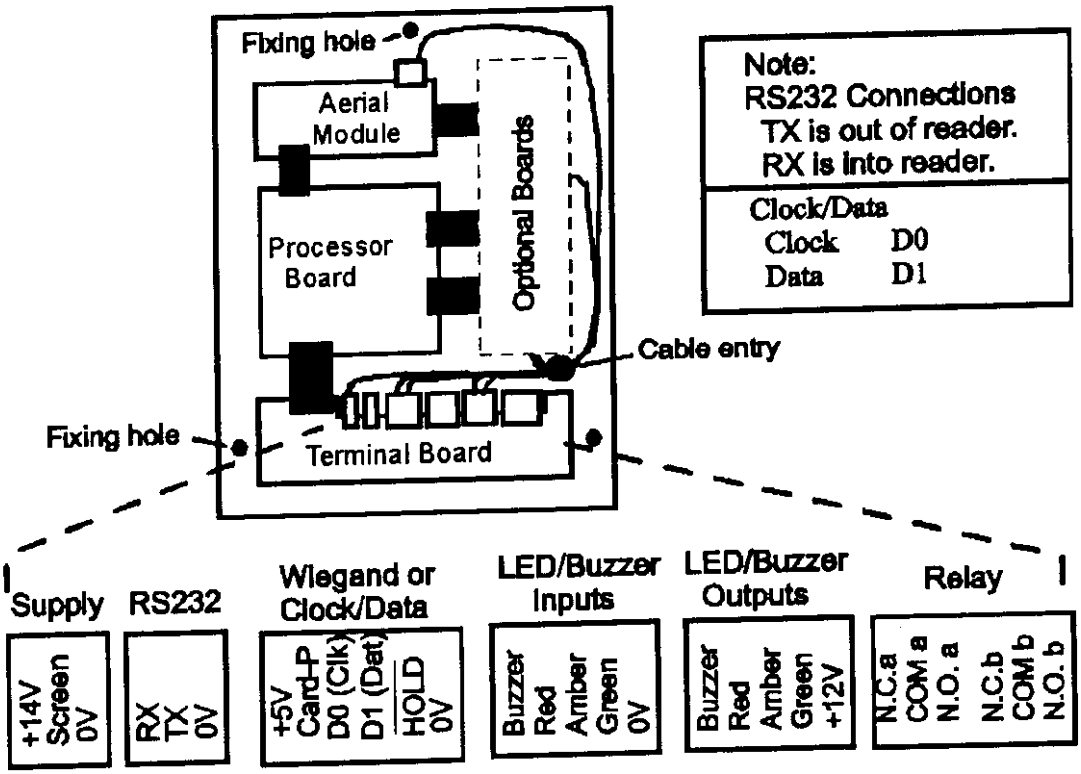
3.4 Installation of the basic reader

This applies to all readers, with or without external aerials. If optional boards are fitted to the reader, you should install the basic reader first.

Has a Site Survey been done? If not, refer to Section 2.

Carefully remove the reader's lid, and put it aside to make sure it doesn't get scratched or damaged. (The lid is held on by 6 M3 screws accessible from the front.) Handle the reader with care, ensuring that the internal components are not damaged. **To minimise the dangers of damage due to electrostatic discharge, avoid touching the circuitry.**

The reader's location (and the type of aerial being used) should have been decided already. If not refer to Chapter 2 and Appendix B of this manual for details.



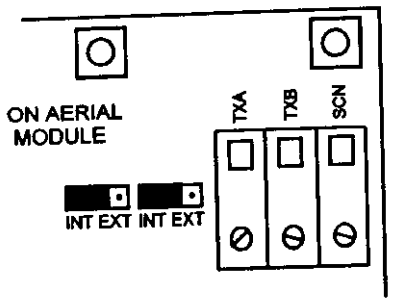
Route the cables to the reader, so that they can come in through the hole in the back panel. All cables for the reader, including those to external aerials will come through the same hole.

Attach the reader using the 3 fixing holes in the back panel. Make sure that the back of the reader is not twisted, and is flat.

If the reader is being installed in an outdoor location, take the reader off again, and waterproof the cable entry area and fixing holes. See Section 3.5.

Connect the cables to the appropriate terminal blocks, except for the +14V input. **(Remember to use the screwdriver provided for the terminals, and unscrew the terminal before inserting the wire, to make sure that the terminal is open.)**

If you are using external loop aerials, it is usually best to commission the basic reader, before switching over to the external aerial(s). (*Such readers should have an internal ferrite aerial. If they have a large internal loop, and the reader is in or on metal, reading may be affected.*) Make sure the links on the Aerial Module are set at INT.

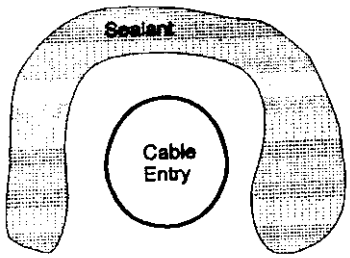


If the reader has two Aerial Modules, connect the wiring to the second aerial, **but leave the links on both Aerial Modules at INT.** This will allow you to commission the reader using only the internal aerial. If you are using an Aux Comms Board, you may find it easier not to connect wiring to it at present. (This will depend on the system to which it is connected, so this manual cannot lay down hard and fast rules.)

3.5 Waterproofing the reader

The CR1 reader's lid is fitted with a sealing gasket to prevent water ingress. **(The gasket will only seal properly if the reader's base is flat.)**

The cable entry hole must be protected to ensure that water does not get in. The cable itself should be angled so that water will not run into the reader. Apply a silicone based sealant around the cable entry hole.



This should be taken around the top and sides of the hole, but take care to leave a gap at the bottom. (If there is any way that water gets in you need to make it easy for the water to get back out.) Reattach the reader before the sealant dries off, making sure that the sealant will stop any water running down into the cable entry hole. The reader's fixing holes, and any other holes in the base plate, should also be protected.

If there is a danger that water may get inside the reader, consider drilling holes in the bottom of the reader baseplate to allow water to drain out. (This may be advisable where condensation forms easily on the inside of the reader.)

3.6 Mullion Aerial

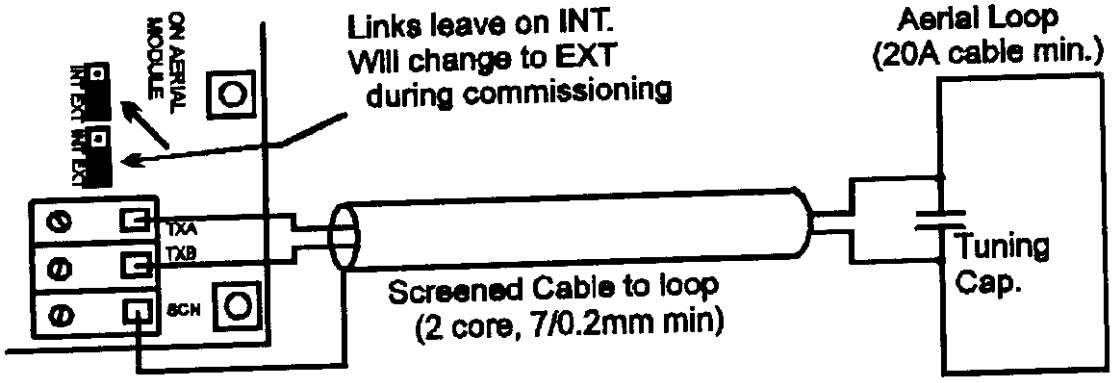
External aerials are usually large single turn loops, but an exception is the Mullion Aerial. The Mullion Aerial is self-contained, and is already fitted with an internal tuning capacitor. It is supplied with a cable, which can if necessary be extended up to 10 metres (33 ft) in length. The Mullion Aerial is fitted with a 6 core screened cable:

Screen	SCN on Aerial Module
Black	TXA on Aerial Module
Blue	TXB on Aerial Module
Red	Red on LED outputs block on Terminal Board
Green	Green on LED outputs block on Terminal Board
White	+12V on LED outputs block on Terminal Board

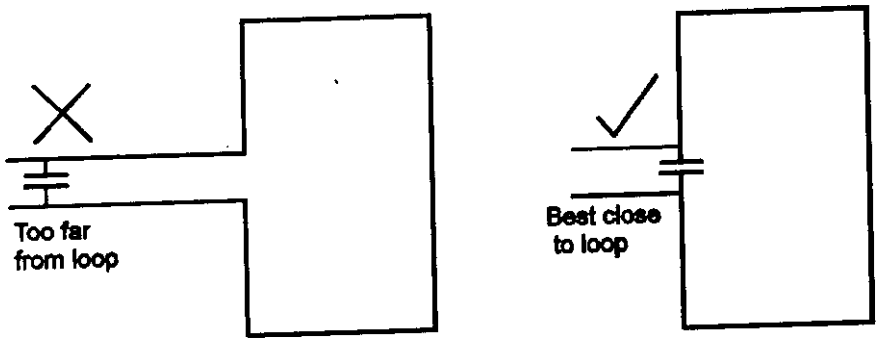
3.7 External Aerial Loop Installation

The wire of the loop must not be positioned on a closed metal frame. Appendix B.5 contains some suggestions of how to mount loops when there is a metal frame.

An external loop is connected to the CR1 reader electronics using up to 10 metres (33 ft.) of 2 core screened cable (7/0.2mm or 24 a.w.g. minimum). The two cores are connected to the TXA and TXB terminals. The screen should be connected to the terminal marked "SCN".



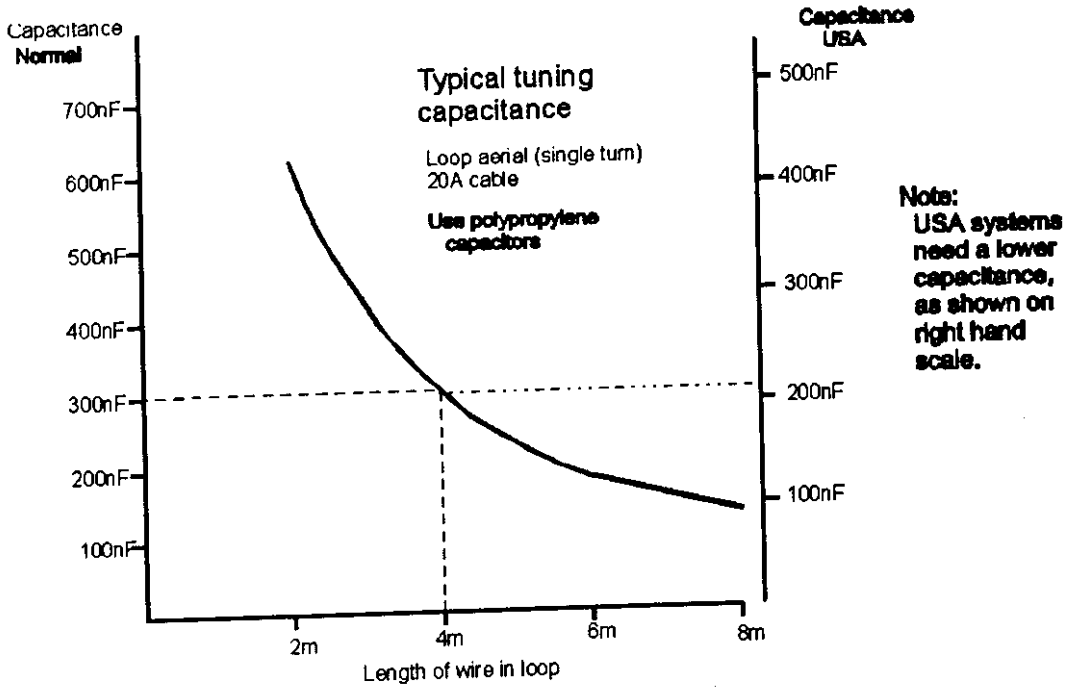
The tuning capacitor should be fitted across the loop, **as close to the loop as practical.** The loop itself should be made up of heavy duty wire, with a continuous rating of at least 20A. If the wire is too thin it will reduce the range achieved, as will having a significant distance from the tuning capacitor to the actual loop. The connections between the tuning capacitor and the loop should be well made. If a terminal block is used it should checked for the tightness of connections.



It is better to be able to adjust the tuning capacitance during commissioning, to obtain the best tune. It is recommended that you use an Identec Tuning Module (Part No 91-8968), which is a simple capacitance box. Alternatively you can select capacitors for your application. (The capacitors should be polypropylene, 250V minimum rating. Identec can supply suitable capacitors.) If you are fitting a reader in an outdoor application, make sure the tuning capacitors are suitably protected. (This means waterproofing them, and if necessary giving them physical protection.)

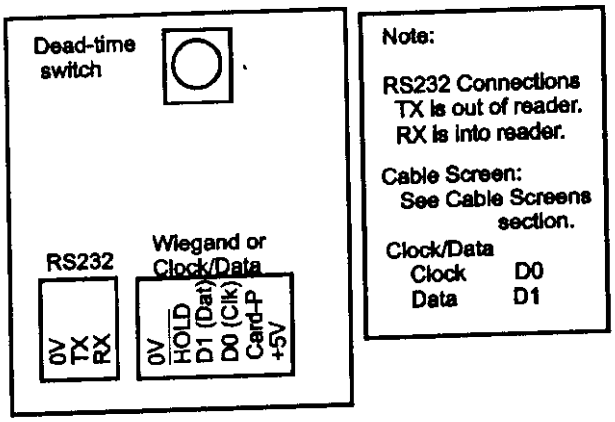
The value of tuning capacitor needed will depend on several factors:

Length of wire in loop	(most important)
Shape of loop	(less important)
Diameter of wire	(less important)
[1]Presence of nearby metal	(can be important)



[1]Metal may also seriously affect reading range.

3.8 Auxiliary Comms Board



The Auxiliary Comms Board will be fitted on some readers (usually CR1-DS dual aerial readers), and the reader will contain appropriate software. (Refer to Section 4.3 and Appendix D.) The Auxiliary Comms Board should be wired as shown. **The 0V connections to the Auxiliary Comms Board are duplicates of other connections, and may cause "earth loop" type problems. If tag data is not reported correctly, try removing these connections.**

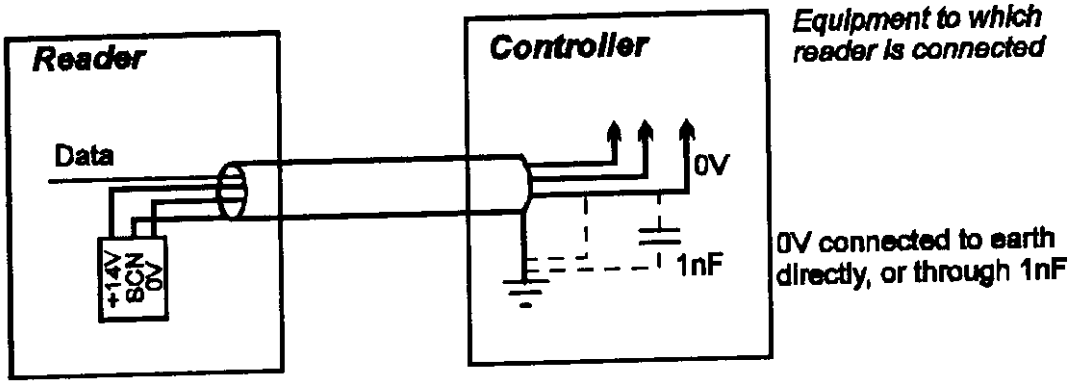
3.9 Cable Screens

All cables should be screened, and the cable screens must be connected correctly.

Main cable - to SCN connection on Terminal Board.
Aerial cable - to SCN connection on Aerial Module.
Aux Comms - to SCN connection on Terminal Board.[2]
Other cables - to SCN connection on Terminal Board.
(e.g. remote indicators)

The screen of the main cable (to the Terminal Board) should be connected to earth at the Controller end.

If the 0V connection to the reader is not connected to earth at the controller (i.e. the other end of the main cable from the reader), there should be a 1nF capacitor between 0V and earth at the controller end.



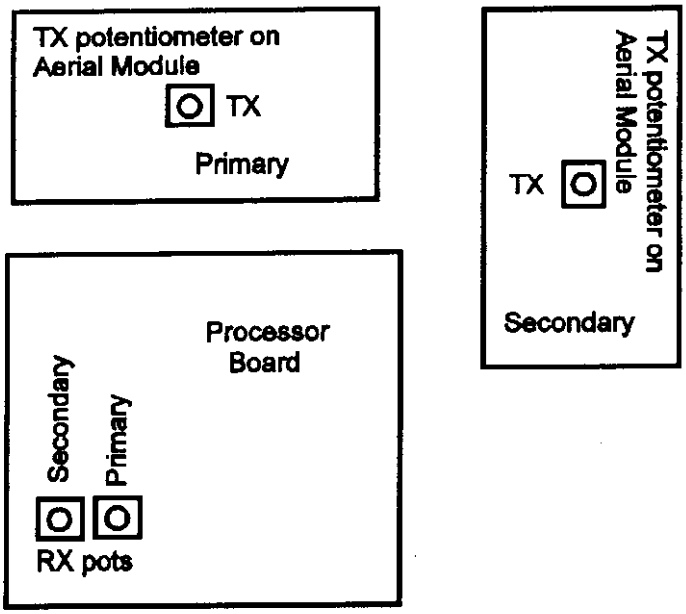
[2]If this causes earth loop problems, insert a 1 nF capacitor in series.

4. COMMISSIONING

4.1. Basic reader with internal aerial

It is better to commission the basic reader first with an internal aerial. Readers for use with external aerials should have a small ferrite inductor acting as an aerial. It is fitted near the aerial connections on the Aerial Module and has a range of 10cm (4 inches). If the reader has an internal aerial loop around its perimeter there may be reasons[1] why you cannot commission the reader with its internal aerial. If so connect the external loop (and put the links to EXT), but note that the reading range will be different. Furthermore the current consumption may be excessive if the loop is not tuned properly.

Make sure that the TX potentiometer on the aerial module, and the RX potentiometers on the processor board are turned fully clockwise. (This is the factory setting.)



Connect a d.c. current meter (ammeter) in series with the +14V supply line, and power up the reader. The current should be about 160mA for a standard reader, but will be more if some optional modules are fitted.

Standard reader	160 mA
LED module	add 100 mA
Second aerial module (no loop fitted)	add 20 mA
Auxiliary Comms Board	add 15 mA

If the current exceeds the expected current by more than 100 mA, switch off immediately and check the wiring. If the current is still higher than expected, refer to the Troubleshooting section (Chapter 5).

Check that the green LED on the aerial module is on. If it is not, and you intend using the internal aerial, refer to the Troubleshooting section.

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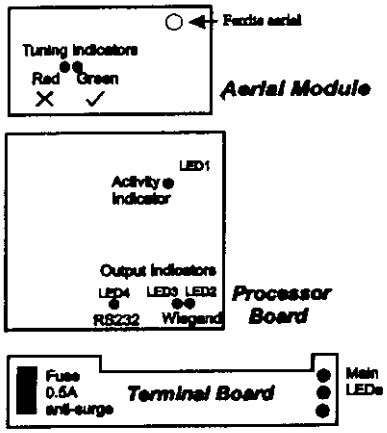
[1] Such as the reader being in a metal box, or mounted on a metal surface.



LED Indications

	No tag	Tag first identified	Tag still present
Terminal Board *(software defaults)*			
# Red	ON	Flashes off	ON
# Amber	OFF	Flashes	Flashes
# Green	OFF	Flashes	OFF
Processor Board			
Activity Indicator	OFF	Flashes 12/sec	Flashes 12/sec
	(Activity Indicator LED on for 1 sec at power up.)		
Output Indicators	OFF	Flashes	OFF
	(Flash briefly at end of power up.)		
Aerial Module			
Red	ON means the aerial is out of tune.		
Green	ON means the aerial is in tune, or open circuit.		

When the reader is first powered up, it will go through a start-up sequence, shown by the Activity Indicator LED on the processor board coming on for one second, followed by the Output Indicators flashing briefly. After this the Activity Indicator will also come on (and flash at around 12 times per second) when there is a tag close to the reader[2]. If there is no tag present, the Activity Indicator should be off. If it is flickering without a tag near the reader, there is interference at 98kHz (in USA 115kHz). You should investigate the source of the interference. (see the Troubleshooting section)

Check that tags are detected at a range of about 1.2 metres (4 ft) with the large internal loop, or 10cm (4 in) with the ferrite aerial. First check that the Activity Indicator LED (LED1) on the processor board indicates that the tag is being read, then check that the tag is being reported. (For Wiegand or Clock/Data outputs, LED2 and LED3 will flash while the data is being sent. All readers will flash LED4 while data is being sent. #Some versions will also give an audible beep when a tag is first read.) Once a tag has been reported, it will usually have to be removed from the reading zone for several seconds

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[2] Some special versions of software may flash less frequently.
#Software options can affect performance.

before it will be reported again. If tags are not being read or are being read but not reported, refer to the Troubleshooting section.

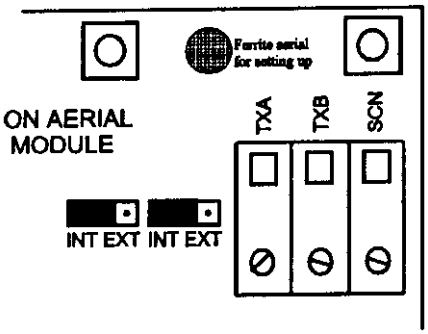
If the reader is to use external aerial loops, refer to section 4.2.

If the reader is using the internal aerial, you may wish to reduce the reading range. To do so turn the TX potentiometer on the aerial module anti-clockwise to achieve the desired range. It is rarely necessary to adjust the RX potentiometers.

4.2. External aerials

It is assumed that you have already commissioned the reader with its internal aerial, as described in Section 4.1 above. (If you cannot use the internal loop, you will have shown that the reader works with the external loop, but it will not be optimised.)

When you change to the external aerial, make sure you change the 2 links on the Aerial Module from INT to EXT.



Mullion aerials should now operate correctly. Their reading range should not normally need to be adjusted, and both TX and RX potentiometers should be fully clockwise.

Adjust the tuning capacitor to bring the aerial into tune. If the aerial loop is not properly tuned, the range will be reduced, and the reader will take more current. **You will not get more range from the reader if it is out of tune, even though it takes more current. All you do is create heat.** It is important for the aerial to be properly tuned, particularly for smaller loops.

Possible techniques for tuning the aerial. Select the one you find most suitable.

1. If you have an Identec Tuning Unit, remove the connections to the reader, and connect the Tuning Unit to the aerial loop and capacitors. Follow the instructions that come with the Tuning Unit, which will tell you whether the capacitance is too high or too low. Remove the Tuning Unit, and connect the aerial to the reader.

OR

2. Adjust the capacitance so that the green LED on the Aerial Module is on. If it is on over a range of values, go for the middle of the range. This is adequate for most applications.

   (If you cannot find any capacitance value which gives green, turn the TX pot down a little. This has the effect of widening the range where you get the green LED on. When you are nearer a good tune, turn the TX pot back up. Remember to put it

back to fully clockwise when you finish. If the green LED won't come on with the TX pot fully clockwise, and you are sure the aerial is tuned, don't worry.)

OR

3. Put a meter in series with the 14V power input to the reader. Adjust the capacitance to give minimum current.

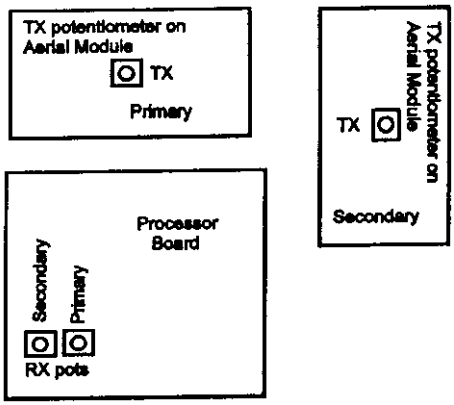
OR

4. If you have a dual-trace oscilloscope with you, the best tune is when the voltage across the coil is exactly in phase with the amplifier output. Connect probes either side of R20 on the Aerial Module, with the ground connection on TP7 on the Processor Board. With too little capacitance, the signal from the right hand side of the resistor (the smaller signal) will lag, while with too much it will lead.

   It is not a good idea to adjust the capacitance to give maximum range. This is rarely accurate enough, and usually gives excessive current.

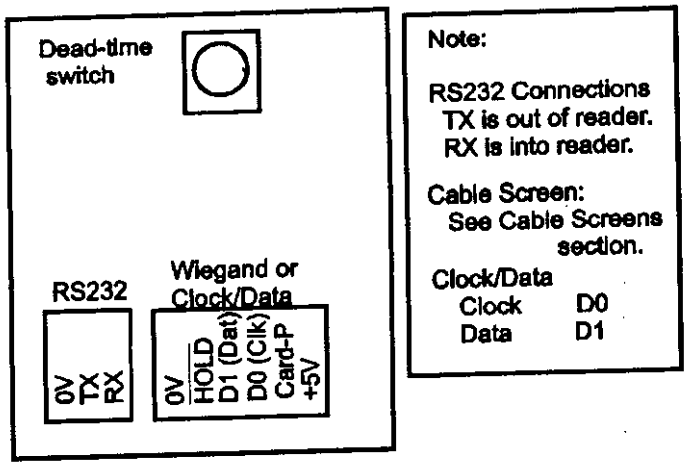
You may wish to reduce the reading range. As with internal loops, you should turn the Aerial Module's TX potentiometer anti-clockwise, until you get the range you want. It is rarely necessary to adjust the RX potentiometer.

For readers with two aerials, each TX potentiometer is on the appropriate Aerial Module. The RX potentiometer for the primary Aerial Module (above the processor board) is the right hand (inner) one, which is marked RXA.



If you are using two aerials, you should check the tuning and range of each with the other disconnected from the reader, but with the tuning capacitors attached. They are unlikely to affect each other unless they are very close. If the application requires that the reading zone of the two aerial loops do not overlap, check that there really is a region between them where tags are not read, by disconnecting each aerial loop in turn to measure the extent of the other's reading zone.

4.3 Auxiliary Comms Board (fitted to CR1-DS readers)



If you are using the Aux. Comms Board with a Direction Sensing option, the Dead Time switch may need to be set.

For the Direction Sensing (Control) software option, a tag will be reported when it is first seen at one aerial[4], but it should not reported again if it is then seen at the other aerial within the period set by the Dead Time switch.

For the Direction Sensing (Tracking) option, a tag will only be reported if it is seen at both aerials within the Dead Time. It is reported from the aerial that sees it last.

For the Safety option, the tag will only be reported once it has left one or the other reading zone for the Dead Time. The tag is reported from the aerial which saw it last, but the tag will be reported even if only one aerial sees it.

The time is normally increased by one second per notch.

(Where the CR1 is being used with the two aerials acting as two essentially independent readers, the Dead Time switch has no effect.)

4.4 User Instruction

Before you leave the site at the end of commissioning, please devote some time to User Instruction. The information you need is in Appendix F.

[4]Each aerial of the CR1 behaves as a separate reader in these options.

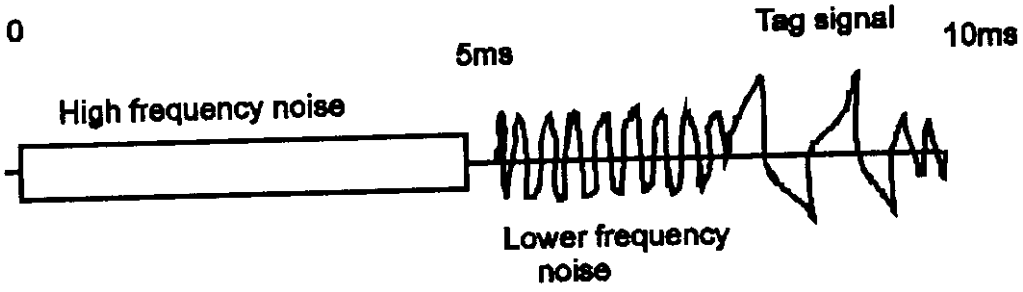
5.3 Interference

Some types of interference are not detected by the Activity Indicator LED. These can be checked using an oscilloscope.

Connect the 'scope probes to the Processor Board, and set the 'scope as follows:

Signal probe to TP1 or TP2 for the Primary Aerial Module.
(TP3 or TP4 for the secondary Aerial Module.)
Probe earth to TP5 (0V)
Trigger probe to TP8 (Trig.)[4]

Signal 200mV/cm, AC coupled
Timebase 1ms/cm
Trigger on -ve edge.



(**Note**: For USA systems, the trace will be compressed in the time scale.)

With no tags present, the trace has two distinct parts, separated by a small gap after 5ms (in USA, 4.2ms). The first part is when the reader is transmitting, and there is some high frequency noise. The second half of the trace is when the reader is receiving, and there will be some lower frequency noise. If a tag is brought in to the reader, its signal will appear in this part of the trace, somewhere between 5ms and 9ms (in USA 4.2ms to 7.5ms). The tag signal will move about within this region, but for each tag it will last 1ms (in USA 0.8ms).

Check the noise level on the right hand side of the screen, in comparison to the signal from a tag. Interference will stop a tag from being read when its magnitude is similar to the signal from a tag. For full reading range, this corresponds to about 100 to 200mV peak-to-peak. This figure is the same for all aerial sizes, but the larger the aerial, the greater the voltage from the same interference source. (CR1-DS1 readers with separate receiver aerials will usually show a little more noise.)

Very strong signals can affect the reader's receiver, yet might not appear at the receiver's demodulator output. Such interference may be observed on TP7 (TP6 for the secondary Aerial Module), where the normal noise level is about 0.5V peak-to-peak.

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[4] Except on readers that use the Card Present output on the Aux Comms Board. An alternative trigger signal is pin 11 (the right hand pin) of the L2750 power amplifier (heatsinked) on the Aerial Module.

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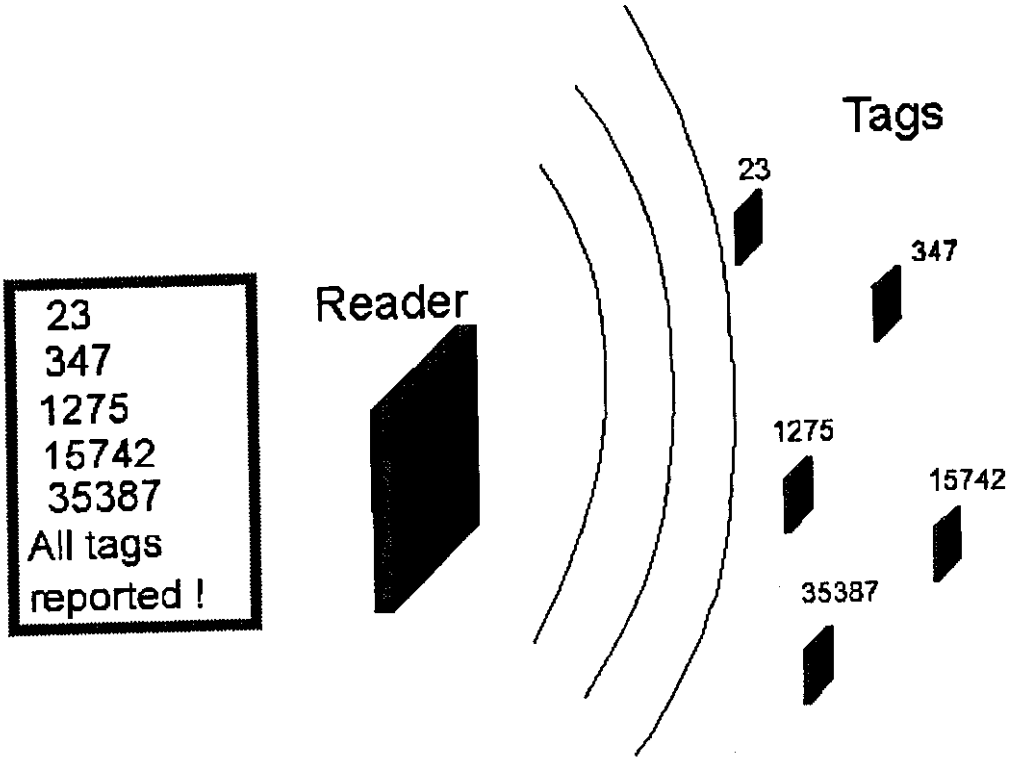
APPENDIX A TECHNICAL DATA

A.1 Reader operation

The reader transmits radio signals continuously, and when a tag detects these signals, it responds and is identified.

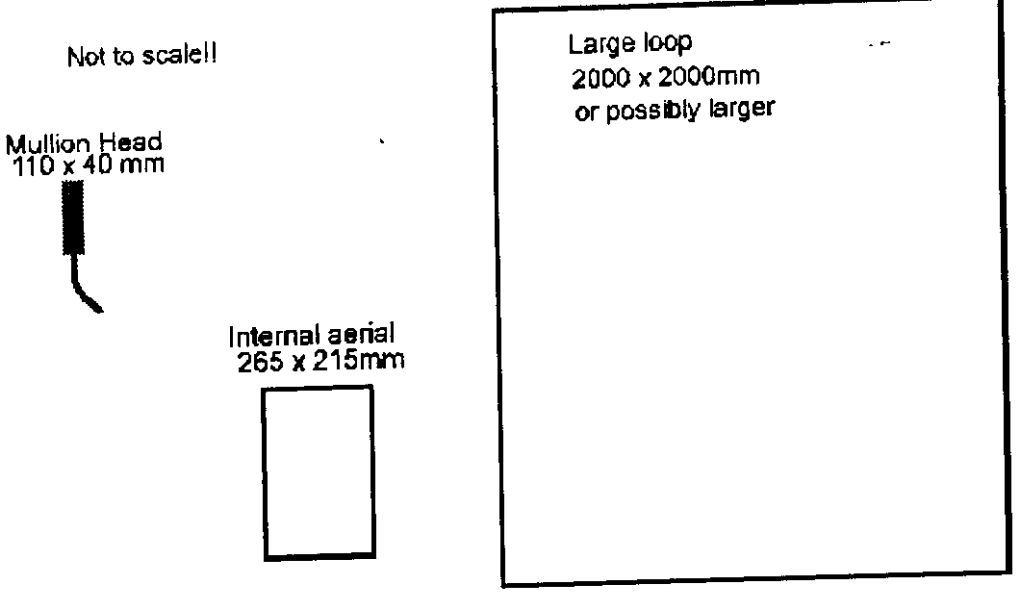
Cryptag Census is a very advanced form of RFID, and uses a dialogue between the reader and all of the tags present, to ensure that every one of the tags is identified. The signals from the reader to the tags, and back from the tag to the reader are coded. The reader interrogates the tags, and only those tags it has addressed are authorised to respond. The ability to read many tags at once is referred to as multiple reading.



The tags are coded with a 64 bit identity number, although many applications will only use 32 of these 64 bits. The number of bits that are read, and the way those bits are formatted in the output from the reader, are determined by the reader's software. The reader's software has been designed in such a way that it can easily be configured to meet many common requirements.

The reader interrogates all tags present, and uses a disciplined dialogue to establish the identity of each and every tag present. The main part of this dialogue reveals the public part of the code, which is called the PID. The PID can be from 1 to 65535. Once it has discovered a tag's PID, the reader then asks the tag for the remaining parts of the identity number (the HIDs). Multiple reading only works when interrogating the PID, so you should avoid having 2 tags with the same PID on the same site.

A Cryptag Census reader uses a single aerial coil for transmission to and from the tag. A wide range of aerial sizes can be used, to suit particular requirements.



Cryptag Census is a radio frequency product, and can be affected by interference. Although the transmission from reader to tag can be affected, it is much more likely that transmissions from tag to reader will be affected by interference (at around 98.3kHz, or in USA 115.2kHz). Before installing a Cryptag Census system, you should survey the site using the Site Survey Meter, MS2 (in USA MS2A). **(Site Survey Meter MS1 should not be used, as it looks at the wrong frequency.)** You should also consider what else is likely to be installed on the site, especially when a building is being fitted out.

A.2 Radio frequencies

Cryptag Census uses low radio frequencies to communicate between reader and tag. The frequencies used are:

From reader to tag:	131.072 kHz	(in USA 153.6kHz)
From tag to reader:	98.304 kHz	(in USA 115.2kHz)

Both sets of transmissions are modulated at up to 4 kBaud. It is important that the proposed location for the reader is free of interference at these frequencies, particularly the receive frequency of 98.3 kHz (in USA 115.2kHz). Any interference in the region of the receive frequency will seriously affect performance.

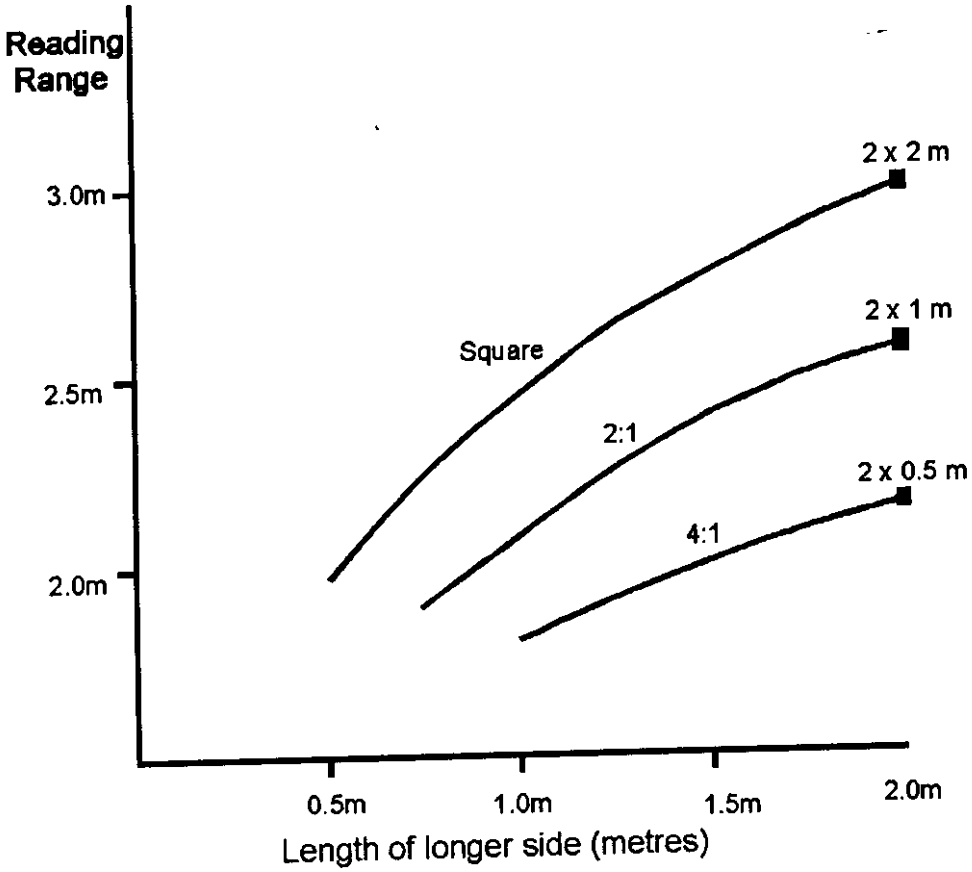
A.3 Reading Range

The reading range is determined by the size of aerial used by the reader and the type of tag being used. The TC1 and TC2 tags give the same range, eg

With internal aerial	1.2 metres
With external 2m square aerial	3.0 metres

(For other tag types see below.)

The reading range depends on the size and shape of the reader's aerial loop, as shown by this graph, which applies to TC1/TC2.



Graph of reading range against loop size (single turn)

These are typical values found under optimum conditions. The reading range is reduced if there is interference, or if the reader is mounted near a closed metal loop.

There are many applications where it is desirable to reduce the reading range. This is easily done, using the potentiometers on the reader.

The reading range is an easy number to quote, yet it is also easily misunderstood. Identec (in common with all tag manufacturers) quotes the optimum reading range, which is easiest to measure. The worst possible misconception, which all too easily arises, is that if the quoted range for a reader is 3 metres, every tag that comes within 3 metres will be read. Unfortunately it isn't that simple.

1. The tag must be properly aligned with respect to the reader. Rotating a tag by 45 degrees from optimum orientation reduces the reading range by about 15%. The reading zone is roughly spherical, with the reader at the centre, provided the tag is in the optimum orientation.

2. There are normal production tolerances between readers and tags. Identec aims to quote a range that will be met by most readers and tags. This gives a conservative reading range in most cases, so be careful in those cases where too much range is a problem.

3. Cryptag Census, being a radio product, can be affected by interference. The background level of interference varies considerably from place to place.

4. The reader may not be installed in the best place or the installation is not quite perfect. The aerial may not be properly tuned, the reader may be next to a source of interference, or there may be a metal loop sucking energy out of the reader.

A.4 Mechanical details

Reader CR1 (also CR1-DS, CR1-DS1, and USA versions CR1A etc.)

Dimensions	300 x 230 x 40 mm (11.8 x 9.05 x 1.6 inches)
Weight	1.5 kg (3.3 lbs)
Colour/Material	Charcoal grey polycarbonate
LEDs	Independent Red, Amber, Green (plus internal buzzer)

Tag TC1 (Personnel tag, also USA version TC1A)

Dimensions	86 x 54 x 4.5mm (3.4 x 2.1 x 0.18 inches)
Weight	30 gram (1 ounce)
Colour/Material	White ABS
Battery life	The normal life is at least 5 years, with up to 10 minutes reading per day. The quoted shelf life of the batteries is 7 years. *If the tag is left in the reading zone, the battery life can be reduced to as little as 3 weeks.*

Tag TC2 (Article tag, also USA version TC2A)

Dimensions	56 x 76 x 6.5mm (2.3 x 3 x 0.25 inches)
Weight	30 gram (1 ounce)
Colour/Material	Black, cream or grey ABS, epoxy filled.
Battery life	As TC1.

Tag TC3 (Article tag, also USA version TC3A)

Characteristics as TC2.
The TC3 is specifically designed for mounting on to metal surfaces. Its reading range is reduced by the metal, but not by as much as a TC2.
Note: The optimum orientation for a TC3 tag is rotated through 90 degrees from that of TC1/TC2.

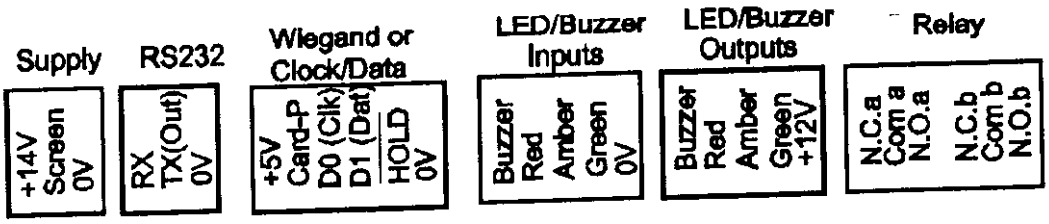
Tag TC4 (Keyfob tag, also USA version TC4A)

Dimensions	42 x 54 x 17mm (1.7 x 2.1 x 0.7 inches)
Weight	15 gram (without battery), 18g (with battery) 0.5 ounce (without battery, 0.6 ounce (with battery)
Battery life	as TC1
Colour/Material	Black ABS.
Performance	66% of TC1 (i.e. ranges quoted in this manual).

A.5 Electrical connections, and interface

The Cryptag Census reader has a number of different electrical interfaces, to give maximum flexibility. Most installations will not need all that is available.

Screened cables should be used. Refer to the section on cable screens (Section 3.9).



Terminal Board Connections

Power Nominally 14V dc (Range 12V to 26V)

Current Consumption:

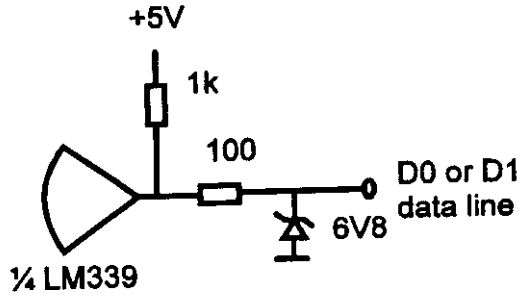
Basic reader	200 mA max. (if aerial tuned)
2nd transmit aerial (CR1-DS)	add 60 mA max.
Remote LED readout	add 120 mA max.
Aux. Comms Board	add 30 mA max.

RS232 Input/Output

9600 Baud, 8 data bits, no parity, one stop bit.
TX line transmits data on all tags reported, and is useful for local diagnostics.
RX line normally not used.
(#RS232 port can be modified as a software variant.)

Wiegand output

#Data on D0 and D1. Output normally at 5V, and pulses low (to 0V) for typically 50µs. Pulse separation nominally 1.6 ms. Next transmission will not start until after a 100ms delay.
Wiegand format, and timings are determined by software version.



Wiegand output circuit schematic

The +5V terminal can be used to power external equipment. **It must not be connected to another voltage source.**

$\overline{\text{Hold}}$ line can be used to make the reader cease transmitting Wiegand data. If this line is pulled low, the reader will complete the current transmission, but will not start any more until Hold goes high again.

#The Card Present line can be configured to go low whenever a tag is present. (For Clock/Data output format)

#Software options can affect performance.

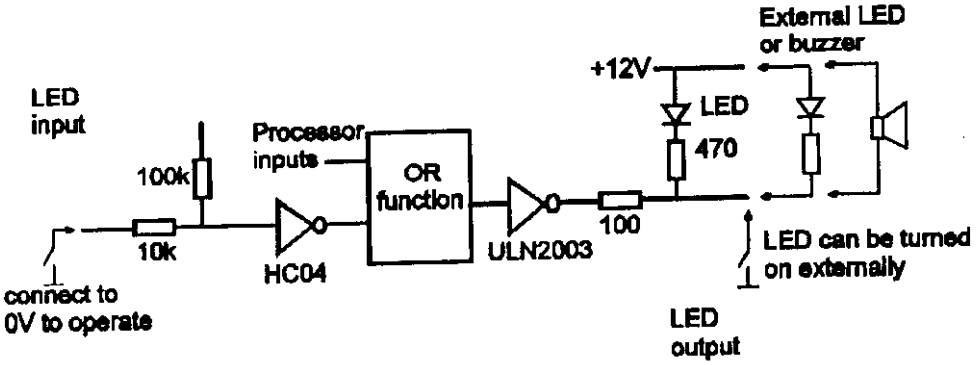
Buzzer and LED, inputs and outputs

The buzzer and LED connections are designed to allow maximum flexibility for the installer. The reader has 3 internal high brightness LEDs (red, amber and green) and a buzzer, which can be controlled either by the reader, or by external inputs.

#The way in which the LEDs operate depends on the software version you have. The processor may operate some of the indicators following a tag read etc. This is a software option, programmed into the readers by Identec.

#In most software versions, the indicators can also be operated by taking the appropriate LED (or buzzer) **input line** to 0V. (Internal resistors pull the input lines up to 5V.)

It is also possible to operate an LED or the buzzer by taking the **output line** to 0V. This is independent of the processor, and is a useful diagnostic aid. It is not recommended for normal operation, because the switching circuitry must be able to handle 12V and at least 20mA.



External LEDs and buzzer can also be used. These will totally mimic the state of the internal LEDs and buzzer. Connect an external LED **and its series resistor** between the LED output terminal and +12V. External buzzers should also be connected between the terminal and +12V, but don't need a series resistor. You must ensure that the LED or buzzer that you use is suitable.

The maximum current that may be taken for an external LED or buzzer is 20mA. This current must be added to the power supply requirements.

Relays

The Cryptag Census reader is fitted with two independent single pole changeover relays, whose operation is determined by software. The relay outputs are rated at 1A, 42V. Ensure that any circuit you connect is suitable.

Auxiliary Communications Board

The Auxiliary Comms Board (CR1-DS and CR1-DS1 readers) has duplicate RS232 and Wiegand outputs. These are similar to those of the main terminal board, and are used to mimic a second reader, for instance in Direction Sensing applications. The Auxiliary Comms Board contains the Dead Time switch which determines the timing in these applications. See also Appendix D.

#Software options can affect performance.

External Aerials (Primary or optional second aerial module)

The reader is fitted with an internal aerial loop, but this can be replaced by an external aerial. An external aerial loop will also be required if the reader has a second aerial module fitted.

Tamper Loop

The reader may be fitted with a Tamper Loop option. Details are provided with the appropriate readers.

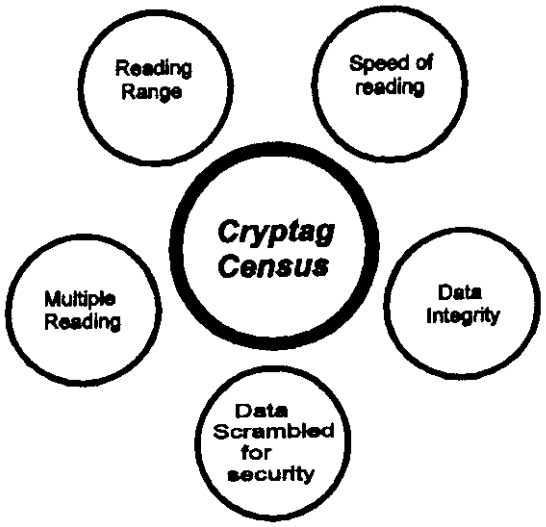
A.6 Operating Environment

Cryptag Census readers are guaranteed to operate over the temperature range -20°C to +60°C. If a reader is to be operated for long periods at low temperatures, consideration may need to given to preventing condensation inside the reader.

Readers can be used in outdoor applications, but consideration may need to be given to protecting against water penetration.

A.7 Reading performance & Data integrity

Cryptag Census uses a coded dialogue by which the reader interrogates tags, and determines their identity. Cryptag Census has several features which distinguish it.



In a typical application, a single tag will be read in 78ms (in USA, 67ms. All other times are similarly reduced.), and 20 tags will be read in 1.3 seconds (in USA 1.1 sec.). It will be noticed that the first tag is the slowest to be read, and 10 tags take less than 10 times the time for one tag. (It is possible, by selecting the tags used, to obtain much higher reading speeds - over 50 tags/sec.)

The misread rate is typically below 1 in 100 million reads. This figure covers data transmission errors, but excludes faults in the tag, reader, or the data transmission from the reader. There is a possibility that some sources of interference (such as computer monitors) can produce interference that is slightly more likely to give misreads. On the other hand, very few misreads ever correspond to valid tags, so almost all will be ignored.

The data transmitted by the tag is scrambled, and changes for each interrogation. It is not possible to play a Cryptag's transmission back to the reader, and convince the reader that there is a real tag present.

Performance is usually limited by one or both of

The reading range, and strength of signals. (see A.3)

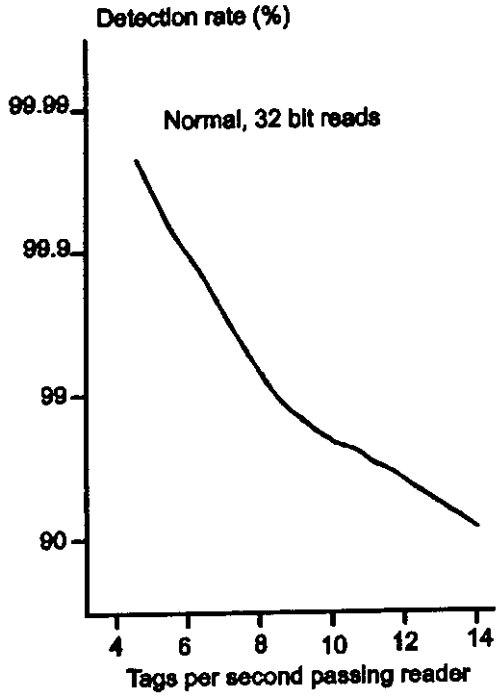
The reading rate.(see A.8)

A.8 Speed of reading

Firstly, a very important point:

If you put 15 tags into the field of a Cryptag Census reader, they will be read in just over one second, but that does not mean that if 15 tags pass the same reader every second, they will all be read.

The number of tags that can be read in one second is called the "static reading rate" while the number of tags that can be detected while they pass the reader is referred to as the "dynamic reading rate". The static reading rate is always higher than the dynamic reading rate. The difference is greatest when the tags passing the reader are in the margins of the field, or their orientation is far from optimum. As these tags pass the reader, they can only be read in some places. If it happens that the reader is busy interrogating other tags, then it is possible for a marginal tag to be missed. Conversely, it is possible to ensure a higher dynamic reading rate by ensuring all tags pass the reader on a path that gives reliable reading. (Typically the dynamic reading rate is around half the static reading rate.)



Detection rate, where all tags are presented in"good" orientation (simulation result).

(Note: USA readers will achieve slightly higher reading speeds.)

A.9. Noise and Interference, and Effects of metal objects

Most of what affects Cryptag readers is actually interference, although it is often referred to as noise.

Tag reading is a 2-way process, but most interference problems affect the much weaker transmissions from tag to reader. The tag to reader transmission is at a frequency of 98.3kHz. (In USA 115.2kHz.)

There are many interference sources that have been identified. Some are rarely seen, but as a result are not diagnosed easily. There will doubtless be some we don't yet know about. Anything that can produce magnetic fields at around 100kHz is a potential source of interference.

Computer monitors

All computer monitors produce magnetic fields from their scan coils. By far the worst are those whose line scan frequency has a harmonic around 100kHz. Modern monitors often change their scan frequency depending on how they are being used. The other variable is how well screened the monitor is.

Some monitors will reduce the reading range of Cryptag Census at a distance of 3 metres (10 feet) or more. Others make no difference at a distance of 1 metre. **When we quote distances in such cases, they are taken from the centre of the reader's aerial**

We advise that users are warned that any computer monitor may have a serious effect, and if necessary you should do a Site Survey. If you get the result that a monitor isn't making a lot of difference, ask them to take it through all the video modes they might use. For instance operate under DOS and Windows, and if any high resolution graphics packages are used, get the user to load them. Only after all of this can you be reasonably confident.

Other CRT (cathode-ray tube) products such as televisions and oscilloscopes can also produce interference, but they rarely present a real problem.

Other electronic equipment

All electronic equipment should be suspect, although very rarely does it cause significant interference. (The tendency towards better control of EMC should help, but few standards limit unintentional emission at 98kHz/115.2kHz.)

Data cables

We have come across cases where computer data cables caused interference which affected readers. This was unusual, and most network cables are very good. You should nevertheless be aware of the possibility.

As with so many interference sources, data cables don't create interference until the building is fully functional. **Beware of doing a Site Survey on an empty building.**

Mains cables

It is more common to see some interference from mains cables. The most usual situation is close to the main distribution board for a building. The reason for this is that this may be where there is a separate earth connection, for instance to ground gas and water pipes. Normally the interference currents in the mains conductors are balanced . The current flows along one core of the cable and back down another, giving only a small net current to create interference. The other connections at a distribution board destroy the balance, hence the problem.

It is best to avoid putting readers close to high power cables, sub-stations etc unless you are sure. This is another case where the interference will go up once the building is occupied.

Fluorescent and Low Voltage Lighting

Both types of lighting can on rare occasions produce interference.

Some fluorescent lights generate radio frequencies, but the emission levels are generally small.

We have come across Low Voltage lighting systems that generate high emission levels in their "transformer" module, which actually contains a switch-mode converter. These do not meet current EMC regulations, but may have been legal when installed.

Other readers (e.g. other Cryptag Census readers)

One potential source of interference that is easily overlooked is other Cryptag readers, and other products that use the same frequency band. Low power products are restricted to a few frequency bands, so there may be cases where two legitimate products are trying to use the same band.

A Cryptag Census tag will not read properly if it is picking up transmissions from two different Cryptag Census readers (or for that matter signals from a Cryptag Census reader and a first generation Cryptag reader). Nearly always it won't respond at all, but if it has started responding to one it may give peculiar responses to both.

(Cryptag Census tags do not respond to signals from tagging systems such as shop-door systems, but the reading range may be affected by their signals.)

To avoid confusion between two readers, it is best to site them well apart so there is a gap between them where the tag responds to neither. We recommend that the distance between two readers is **at least 3 times** their average (transmitter) range.

LORAN radio beacons (not applicable to USA systems)

The 98kHz frequency band is generally quiet, and this is one of its attractions. The reason why it is quiet is that it is reserved for LORAN (LOng RAnge Navigation) radio beacons. These are a world-wide network of radio transmitters which transmit at a centre frequency of 100kHz. If you have an installation within about 100km (60 miles)

of such a beacon, you may see a reduction of reading range. (The beacons are widely separated, so the risk is relatively small.)

A list of LORAN beacons is provided in the Product Reference Manual.

Effects of metal near readers

Usually metal near the aerial of Cryptag readers which reduces performance, but it is possible to use the effects of metal to advantage.

Metal close to an aerial loop can act as a shorted turn, sucking energy out of the reader. It will affect the tuning of the aerial, but even if the aerial is retuned there will be loss of range. The reading zone will change its shape, with the range behind the metal reduced. (We can use that to advantage for screening, as will be described in the next section.)

The effect on the reading range is greater when the metal is closer to the aerial loop. Many factors affect the range, but typically a complete sheet of metal, 100mm (4 inches) behind the aerial loop, reduces the reading range by about 25%. (If the metal is ferrous, it will have slightly more effect.) This is after the aerial loop has been retuned.

When the metal is only close to part of the loop, the effect is reduced. If the metal is only close to one side of the loop the effect is minimal.

As metal affects tuning, metal doors can pose a problem. If the aerial loop is too close, its tuning will change when the doors are open. If the tuning is optimised when the doors are open, the range will drop when the doors close (or vice versa).

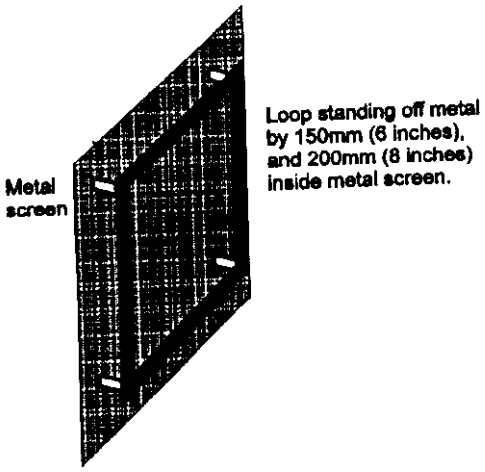
Ferrous metal (e.g. steel) introduces new considerations. A sheet of ferrous metal reduces the reading range by more than non-ferrous metal. It also acts as a better screen, with the range behind the metal reduced to around 50% of the range in front. The shape of the reading zone behind the metal is distorted, making the region where tags will be read less predictable.

Ferrous metal (of any shape) can concentrate magnetic fields, and this has been known to give an unexpected increase in range. On the other hand, it can also concentrate interference signals in towards a reader. What you should be on the look-out for is a situation where a relatively long and thin ferrous metal structure has one end close to the aerial loop.

A.10 Screening

There are situations where you want to have two readers close to each other without interacting, or you only want a reader to read in one direction. It is possible to partially screen one reader from another using metal screens.

The screen should be a sheet of ferrous metal (such as mild steel, but not stainless steel) placed behind the reader's aerial loop. This will reduce the field in the back direction (i.e. behind the screen) but it will have less effect in the forward direction.



The screen should be at least 100mm (4 inches) and preferably 150mm (6 inches) behind the aerial loop, and in the same plane. It should be larger than the loop, extending at least 200mm (8 inches) beyond the loop on all sides.

Screening is not perfect, and the reading range behind the screen can sometimes be over 50% of the range in front of the screen. In critical situations, you are advised to build a full-scale model, for demonstration to the client.

Other points to note when looking at screening are:

With ferrous metal screens, the reading field is distorted. Tags may not be read close up to the screen, while they might be read further away.

The larger the screen the better. An overlap of much more than 200mm is definitely a help. If space is limited, use a smaller aerial.

A sheet of non-ferrous metal (e.g. aluminium alloy) 40mm (1.5 inches) behind the ferrous metal can improve screening.

Where there are two readers on either side of the screen, there will still be some field from each on the other side of the screen. Where this field exists there will be a dead-zone where tags pick up the signals from both readers, and respond to neither. Screening can prevent the wrong reader detecting the tag, at the expense of some loss of performance.

With two readers, one either side of the screen, there is a danger that they might interact if the aerial loops are too close. If you are planning such an installation, seek advice from Identec Ltd.

Appendix B SELECTING THE READER

B.1 The decision process

This appendix describes how to select the reader for a particular location. Consider

What do you want the reader to do?
Where do you want tags to be read?
Where do you not want tags to be read?
What aerial configuration (if any) will meet your needs?
Will it work in the intended location?
Are there any other limitations?

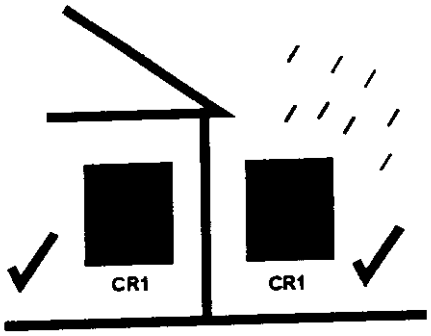
Following this process will help give you a successful installation.

The standard CR1 reader with its internal aerial has a reading range of 1.2 metres (4 feet). This is simpler to install, so should be preferred for all locations where it will suffice. Most of this Appendix is about those locations where you need something more.

B.2 Environment

Cryptag readers work in most environments, over a temperature range of -20°C to +60°C.

The CR1 reader can be installed indoors, or outside. (Outdoor locations require some weatherproofing precautions.)



B.3 Where will tags be read?

In most applications you will want tags to be read as they approach or pass a reader. Tags on those "paths" need to be detected reliably, taking into account their orientation (are the tags horizontal or vertical etc.), and the number of tags passing the reader.

The Data Sheet range is for a tag in the optimum orientation, and a relatively interference-free environment, and many factors can reduce range. Not every tag that just comes within the quoted range will be detected. There will be cases where tags are read at slightly greater distances than you expect. Reading range can be turned down.

If there are metal structures near the reader, reading range is normally reduced, but there are anomalous cases where it is increased.

If you need more than the 1.2 metres reading range of CR1 with its internal aerial, the reader will need an external aerial loop. (The graph in Appendix A.3 shows what range you can achieve for different loop sizes.)

It is important you look all around the reader, in case there are places where you don't want tags to be read. When doing this, think vertically as well as horizontally, and look at other floors if there are any. (The reading range in the plane of the loop is almost the same, so the Reading Zone is almost spherical.)

There are cases where the reading range must be much higher in one direction than another. It is possible to screen the back of an aerial loop, greatly reducing the range in the "reverse" direction, with less loss of range in the "forward" direction. Refer to Appendix A.10. (Alternatively consider separate receivers - see Appendix H.)

B.4 Limitations

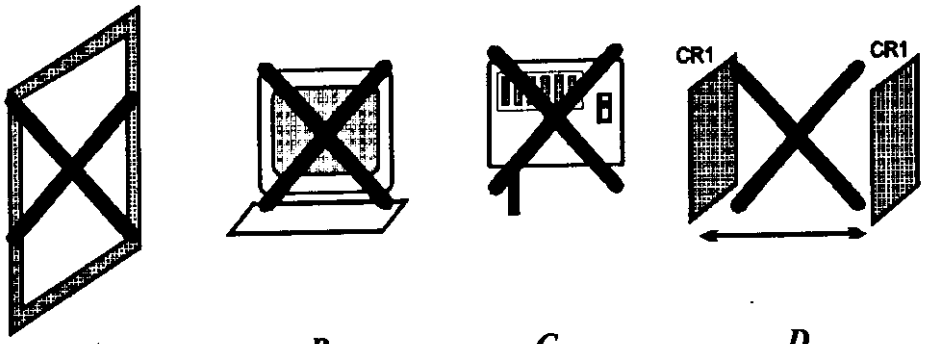
Before deciding on a reader configuration and position, make sure there isn't something that will stop it from working.

Readers should <u>not</u> be installed where performance is going to be affected by external factors such as large items of metal, or equipment that will cause interference.

The reader's aerial should not be installed on a metal surface, which can act as a short-circuit turn to the aerial loop. (There is no problem putting the reader electronics on a metal surface, if there is an external aerial loop away from the metal. If you must have the aerial loop near metal, it may need retuning.)

The reader's aerial must not be installed on to closed metal loops such as partition supports and door frames. The closed metal loop is nearly as bad as a metal sheet. (See the next section - B.5 for more details.)

The aerial loop should be kept away from sources of interference such as VDUs, monitors, photocopiers etc.. Other things to look out for are large cables (mains and data), and ferrous metal near the reader. If in doubt, check the area with a Site Survey Meter <u>MS2</u> (or in USA MS2A). Make sure that possible sources of interference are turned on. (For details of how to use the Site Survey Meter, refer to Chapter 2.)



A Do not position aerials less than 200mm (8 inches) from a metal surface. For more information, refer to Appendix A.9. *There is an exception here if a sheet of metal is being used deliberately as a screen, to reduce the reading range in one direction. Refer to Appendix A.10.*

B Do not position aerials less than 1.5 times the reading range from a computer monitor, e.g. 4.5 metres (14 ft) from a 2 metre (6ft 6 in) square loop.

C Do not position aerials less than 1.0 times the reading range from large mains or data cables unless you have **thoroughly** checked them with a Site Survey Meter. If possible have the plane of the loop at 90° to the other cables.

D Do not position aerials less than 3.0 times the average reading range from another reader's aerial. Once again, think vertically as well as horizontally. For a Direction Sensing option, where the fields from different aerials of the same reader should not overlap, you can get away with slightly less.

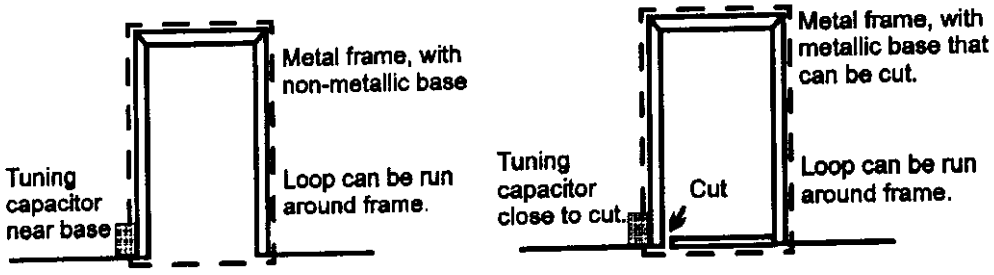
The proposed location should be given a Site Survey, as described in Chapter 2.

B.5 Aerial Loops near metal

There are often situations where aerial loops must go near to metal structures. This section looks at various possible situations, and how to deal with them. Reading range will be affected, but by following these suggestions the effect will be minimised.

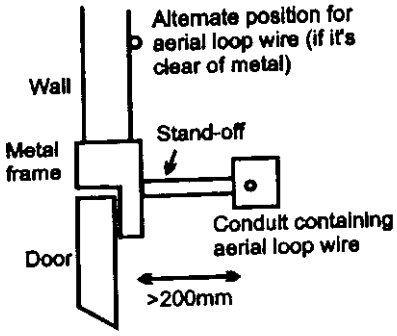
Case 1: Wooden door in a metal frame.

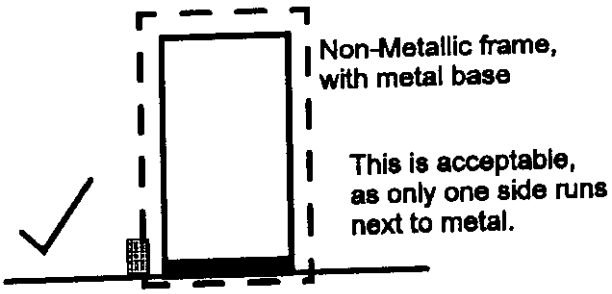
The first question to answer is whether there is a complete closed (electrically conducting) loop, so is the frame connected to metal across its base? If there is not a complete closed loop, then you can put the loop up against the door frame. The tuning capacitor should be located near the base of the door.
(The metal frame will increase the effective wire size, so the tuning capacitor will be slightly higher than normal for the aerial size.)
Be on the lookout for the case where the floor looks non-metallic, but has a metal structure below.



If there is a closed loop where you would like to place the aerial, it may be possible to break it without doing any damage. **(Before you make a cut, you must make sure that it won't affect structural integrity.)** If there is just a metal strip across the base, it may be possible to shorten one end by a small amount, breaking the closed loop. If you can make a break in the closed loop, it is much better if you put the tuning capacitor near to the break.

If you are left with a closed loop that cannot be broken, you must separate the aerial loop from the closed loop. You will need to construct a channel for the aerial, at least 200mm (8 inches) away from the metal frame. Ideally the aerial loop should be on the side where you want better tag reading. Alternatively it may be possible to put the aerial loop on the wall away from the metal frame. (It doesn't matter if the wire has to run next to the base of the frame. One side of a loop can be next to metal, if the other three sides are clear.)





Case 2: Metal door inside metal frame

Under these circumstances it doesn't matter whether the frame produces a closed loop, because the metal door will when it is closed. You must stand the aerial loop clear of the frame as shown above. With the metal door, there will be more difference between the reading range on either side of the door, and between whether or not the door is open.

Case 3: Metal door inside non-metallic frame

In this relatively rare situation, it will probably be best to run the aerial loop in the wall at least 200mm (8 inches) away from the metal door.

Case 4: Metal "tiles" under floor

Metal coated floor tiles are commonly used to prevent static discharges and reduce electrical interference. There may be occasions when you wish to have part of an aerial loop going across such tiles. If the rest of the aerial loop is clear of metal, this is not a problem. It will generally be easier to pass the wire under the tiles, but as only one side of the loop is next to metal it will be all right. (If there is also a metal frame, the aerial loop must be positioned away from the metal, except for the one side that goes under the tiles.)

Appendix C SOFTWARE OPTIONS

The CR1 reader can be supplied with a number of software options to suit customer requirements. This section describes some of them. It is not a complete list. As software options can affect the apparent performance of the reader, they are marked (#) in this manual.

Data output

Wiegand. Format of the output, and timings.
Clock/Data. (As normally produced by Magstripe card readers)
RS232. Baud rate, format.

Reporting

When tag first seen, when it leaves reading zone, both entering and leaving field, or continuously.
Audible beep when tag is detected.
Number of bits read. This affects reading speed.
Only report certain tags.
Report modified number (reported number derived from tag's identity).
Relay control.

Direction Sensing (CR1-DS or CR1-DS1 hardware)

Control version.
Tracking version.
Safety version.

Dual reader (CR1-DS hardware)

Two aerials act as independent readers (but with reduced reading speed).

LED and Buzzers

Regular beeps when a tag is "loitering" near the reader. (Such a tag would be using up its battery life.)
"Low Battery" warning.
Whether external inputs affect LEDs?
Warning on some tags.
Steady or flashing (at rates such as 4Hz, 2Hz or 1Hz).

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Appendix D APPLICATIONS

This section describes a number of applications. These are examples, and not a definitive list of all that Cryptag Census can do. If you have a possible application for Cryptag Census, please contact your supplier, who will be pleased to advise you.

D.1 Access Control Reader

Cryptag Census can be used with almost any physical Access Control system. It can emulate Wiegand or Magstripe readers. Tags can be encoded to your particular requirements, except that some numbers may be unavailable if they could duplicate tags already issued.

The numbers allocated to the tags can be converted by the reader into a format that will suit your Access Control System, and this can include modifying the reported number. Identec will be pleased to advise you.

D.2 Dual Access Control Reader

Several versions of dual reader are available. All have a second Aerial Module fitted, as well as an Auxillary Comms Board.

The Control version of the Direction Sensing reader option assumes a physical barrier, such as a door, which is controlled in both directions. (For convenience we will call these "Entry" and "Exit".)

It would be possible to fit two separate readers when using contact or proximity technologies, but there are reasons why this is not the best solution with a hands-free technology. The reading zone from each reader will extend through the door, so the two readers will interfere with each other. Then having gone through the door, the tag will be detected by the second reader, which may open the door again (with a possible security risk) or at the very least produce confusing reports.

Cryptag Census with the Direction Sense option provides a solution which is technically superior and is cost-effective. There is only one reader, with two aerials and two output ports. The two output ports can be connected to the Access Control system as though they were two separate readers. When a tag is seen first at the "Entry" aerial (i.e. the aerial on the outside of the door), a tag report is sent to the "Entry" port. If the same tag is seen at the "Exit" aerial within the Dead Time (as set on the Auxiliary Comms Board), it will not be reported again. Similarly, tags seen first at the "Exit" aerial are only reported to the "Exit" port.

When using this option, the aerials must be installed in such a way that the tags will be picked up by the correct aerial first. The reading zones can overlap, but there must be no places where only the "wrong" aerial will pick up tags.

The reading speed that can be obtained with this reader option is limited by the total number of tags present at the two aerials, so it may appear to be slightly slower than two separate Cryptag Census readers.

D.3 Tracking

With the tracking version of Direction Sensing, there is no physical barrier. (There can be a door, but it won't be controlled.)

Tags are only reported if they are seen by both aerials within the Dead Time. If a tag is only seen by one aerial, it is assumed to have been passing by the end of the reading zone, and not passing through. If a tag is seen at the "Entry" aerial (i.e. the one on the outside) first, then at the "Exit" aerial, it is reported at the "Entry" port.

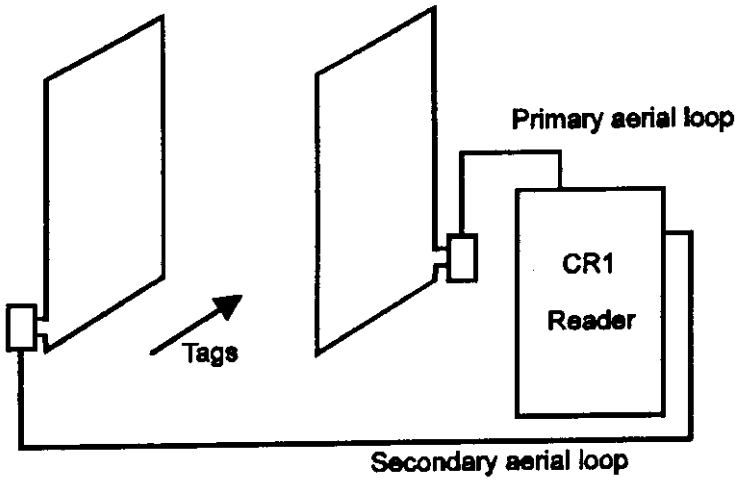
As one reader is reading tags at both aerials, the rate at which people can pass through is determined by the total traffic in both directions.

D.4 Safety

The Safety reader option is similar to the Tracking option, but tags are always reported according to where they were last identified.

D.5 Very High Detection Probability (Master/Slave aerials)

A single aerial loop may not detect all tags that pass it or through it, especially if the loop is large. Where very high detection probabilities are important, the reader should be fitted with a second loop so that the reading zones of the two aerials overlap. This uses a CR1-DS reader, but the Aux Comms board is not connected. (Although there are two aerials, their signals are combined so that they appear to be a single aerial.)



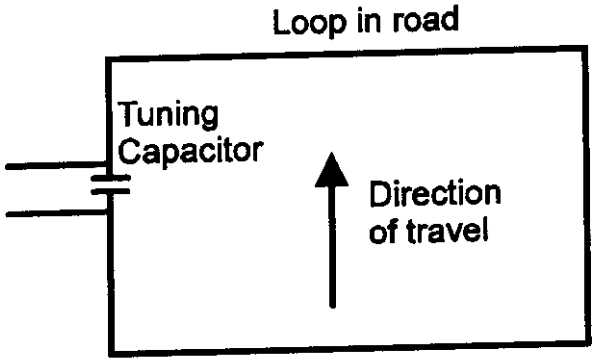
Master/Slave aerials - give improved detection when tags are randomly oriented.

Two parallel aerials (on either side of where tags are to be detected) provide a convenient arrangement. The reader must be modified, so that a tag will be detected if either aerial loop can read it. The detection rate can be increased to well over 99% (as long as it is not limited by the number of tags per second passing the reader).

D.6 Vehicle Loops

The aerial loop for Cryptag Census can be located in a roadway, to detect vehicles as they go past. This is a case where the size and shape of the aerial loop must be tailored

speed of vehicles. (For 50km/h the loop should extend 2.5 metres along the road.) The danger is that you may make the loop too large, to the point where tag reading will be unreliable. No dimension of the loop (length or width) should be more than 4 metres. In some countries, you may not be permitted to use such large loops.



Vehicle tags (TC2) should not be mounted directly on the metal of a vehicle, as this will significantly reduce range. The tags should be separated from metal using a non-metallic spacer, such as those available from Identec. If the vehicles are to be detected at low speeds and the reader aerial is close to the tag, a smaller spacing will be acceptable.

Cryptag Census can be affected by the signals from other vehicle detection loops, which may be positioned in the roadway. These should be checked during a Site Survey. When positioning tags on vehicles, it is best to keep them well away from sources of interference such as the ignition, and fuel pumps.

D.7 Matchmaker (Standalone reader)

There are cases where an article can only be removed by one person. For instance a caravan (trailer) can only be taken out of storage by its owner. Cryptag's Matchmaker caters for this. There are two types of tag, for personnel and articles. They are supplied as matched pairs, to control who can remove the article. e.g.

Person alone	Gate opens
Article alone	Gate will not open. (Alarm)
Article & wrong person	Gate will not open. (Alarm)
Article & right person	Gate opens.

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Appendix E APPROVALS

Cryptag Census generally requires some form of approval, as it is an intentional emitter of radio frequency. This section describes the status of the product in various countries at the time of writing. For more up to date information contact Identec.

United Kingdom

Cryptag Census has been approved by the Radiocommunications Agency

Emission
MPT1337 Approval No. 12561

EC Type Examination of Electromagnetic Compatability
ETS 300 339 Approval No. 12591.

Other countries inside European Union

Cryptag Census has been satisfactorily tested to ETS 300 330, for Radio Frequency emissions. The testing to ETS 300 330 and ETS 300 339 should be acceptable in all European Union countries. However certain national limitations may apply.

United States of America

Approval is awaited.

FCC Identifier: JHD-CEN1
For the purpose of FCC, this range of product is classified as a low frequency intentional radiator. **"The user is cautioned that any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."**

In all countries, this product is approved on the basis that it shouldn't cause interference to others, and that it won't be affected by interference. If you make an unauthorised modification, you may invalidate that approval, and you might be committing an criminal offence (depending on local legislation).

Low Voltage Directive

Cryptag Census readers have been designed and manufactured in accordance with EN60950, following the provisions of the Low Voltage Directive.

ISO 9002

Identec's Quality System conforms to ISO 9002. (Certificate Number - FM36029)

Appendix F USER INSTRUCTION

F.1 After installing Cryptag Census, it is a good idea to make sure that the customer understands how the system works, and how to get the best out of it. What they are told depends on the type of application. This section provides information that will be useful to the manager responsible for the system, as well as the basis for information to give to all tagholders (if applicable).

If personnel are carrying tags, show them how to present a tag to a reader face on. Explain that tags are much less likely to be read if they are on their side (for instance lying in the bottom of a bag).

Tags do not read as well inside bags with metal frames, or surrounded by keys and coins. **The identity of the tag will not be incorrectly reported, but the range may be affected.**

Once a tag has been reported, most software versions will not report that tag again until it has been taken right out of the reading zone for several seconds, then brought back. If you need the door to unlock again, you must walk well away from the reader before returning to it.

Tags must not be left within range of readers. The battery inside the tag will be used up. If the tag is left next to a reader for several weeks the battery would become totally flat.

F.2 Tag disposal

When a tag reaches the end of its life, it should be disposed of properly. As there may be considerable time before this happens, and environmental policy may have changed in the meantime, we recommend:

Tags contain a small lithium battery, and should be disposed of accordingly.

If you are uncertain about how to dispose of tags, they may be returned to Identec for disposal.

F.3 End User Instructions

This section can be used to generate simple instructions for end users.

You have been provided with a Cryptag Census tag.

Application information to be given here.

To get the best out of your tag, would you please spare a few moments to read this.

The tag operates best when it is in the same plane as the readers, which are usually mounted vertically. You will get good performance if the tag is worn vertically, but not so good if the tag is placed flat in the bottom of a bag.

The performance of the tag will be affected if it is surrounded by metal objects such as coins or keys. (The larger the metal object, the more effect it can have.)

This tag has been designed and built to work under conditions met in normal daily use, but for reliable operation the following precautions should be observed:-

1. Do not bend the tag excessively. It should not be kept in the back pocket of trousers, or other places where it may be subject to bending.

2. Do not immerse in water, or allow it to come in contact with solvents.

3. Do not leave the tag in a hot place (e.g. on a radiator).

4. This tag contains a small battery, which under normal circumstances will last 5 years. Battery life will be reduced if the tag is left for long periods within range of a Cryptag Census reader.

Appendix G HEALTH ASPECTS

There has been publicity over recent years about the possible health aspects of products which emit electromagnetic radiation. We have consulted various documents produced by NRPB (UK's National Radiological Protection Board), and the general conclusion is that the risk, if any, is exceedingly small.

Heart Pacemakers

It is impossible to state definitively that there will be no effect, but we know of no case where a pacemaker has been affected by a Cryptag reader.

Concerns were first expressed some years ago, when some pacemaker designs may have been susceptible. As pacemakers are only left in the body for a few years, these should all have been replaced. Modern pacemakers have much better immunity.

It is unlikely that anyone fitted with a pacemaker will be affected, but if there is someone who suspects he has a particularly susceptible pacemaker, they are advised to keep their chest at least 10cm (4 inches) from any aerial loop wire.

Hazardous effect of low frequency emission

There has been publicity about the possible harmful effects of low frequency magnetic fields, which have been linked to a small rise in the probability in the incidence of very rare forms of cancer, usually near power cables. The number of cases in these studies is very low, there is still considerable dispute about the statistics, and if there is a link it may not be the magnetic field. Cryptag uses a higher frequency, which is believed to be less likely to have an effect.

If there are any risks, they are very small. If users are concerned, the most important thing is the exposure time. They should spend as little time as possible within 1 metre of any part of a reader aerial. (The emission from the tag is very much smaller than from the reader.)

Further information, including actual magnetic field levels, is available in the Product Reference Manual.

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APPENDIX H ADDENDUM FOR READERS WITH SEPARATE RECEIVER PODS

H.1. Use of separate receivers

The normal configuration for Cryptag Census readers is to use a single loop for both transmit and receive. This is the simplest to install, and will usually give the best reading performance. Some readers (e.g. CR1-DS) can do direction sensing using two loops (also both transmit and receive) each reading tags in their own vicinity.

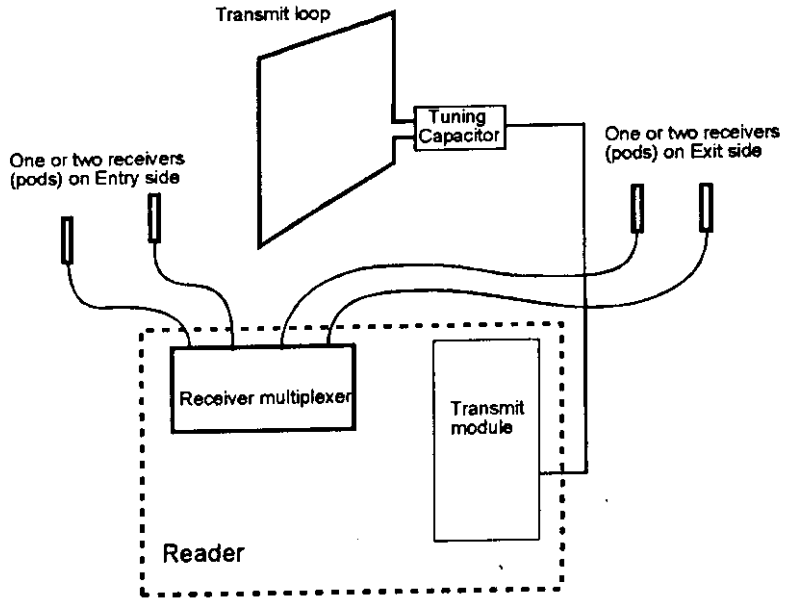
However some installations are better served by separate transmit and receive aerials, such as

A dual aerial (e.g. tracking or control) reader is needed, but it is physically difficult to install two loops. A typical situation is on the exit door of a building, where one loop would ideally be placed outside the building. In such cases only a single transmit aerial is used.

A single aerial is placed around a door, but it is found that there is a localised noise source which is affecting that loop. In some cases it may be advantageous to separate the receiver and locate it away from the localised noise source.

One important factor to bear in mind is that separating the transmit and receive aerials will reduce the overall detection rate of tags that pass the reader. With a single aerial, a tag will be read if its coil links with the aerial loop. When a separate receive aerial is added, a tag will only be read if it links with both the transmit and receive aerials. When installing separate receivers, the secret is to locate the aerials so that tags will link into both aerials at the same time.

The CR1-DS1 reader is designed for use with separate receivers. It has only one transmit aerial connection, but will handle up to 4 receiver pods. The signals from these can be combined (as two pairs) to improve the detection of tags.

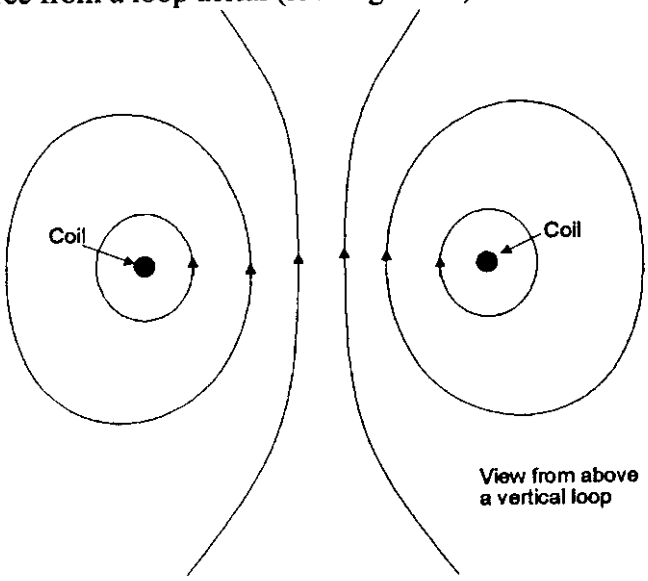


H.2. Selecting the location of the aerials (principles)

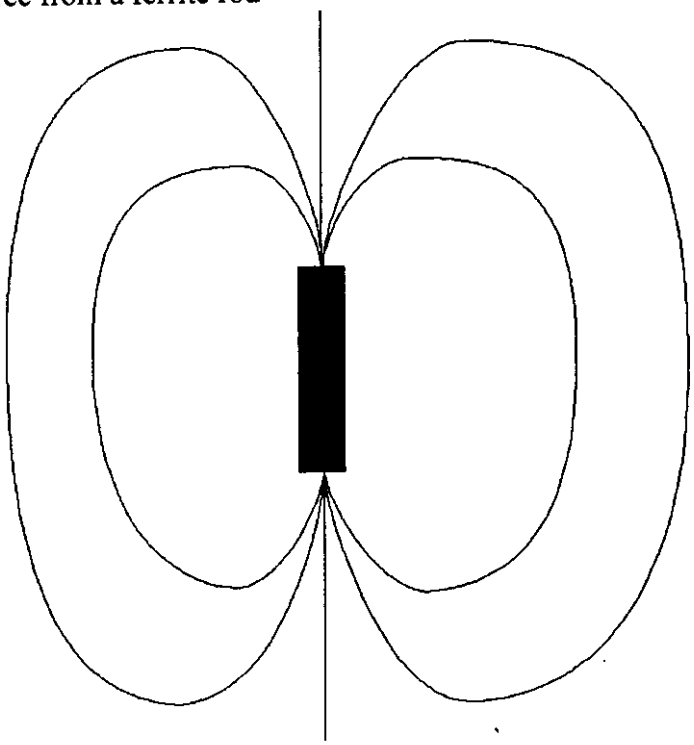
Firstly a quick refresher on the shape of the fields created by the type of aerial used with Cryptag Census. The transmitting aerial will usually be a large loop. (It is possible to use a coil wound on a ferrite rod, but to achieve a significant range a very large rod is needed.) The receiver aerial will be a "pod" consisting of a ferrite rod and pre-amplifier housed in a plastic tube 180mm long and 20mm diameter.

Although the receiver pod is not acting as a transmitter, the shape of field it would create as a transmitter also tells us how well it is going to couple in to the tag, and receive signals from the tag.

Lines of force from a loop aerial (looking down)



Lines of force from a ferrite rod



It is useful to note that the fields look different close to the aerial, but well away from the aerial they both create the same shape. The axis of the ferrite rod goes along the rod, while the axis of a loop is perpendicular to the plane of the loop. (It is possible to replace the ferrite rod receiving aerial by one based on a flat loop, and this may be easier to install in some places. For details contact Identec.)

The ideal arrangement of the transmit and receive aerials would be one where the lines of force for the two aerials are parallel wherever tags are to be read. In addition the direction of the lines of force should be such that a tag in its typical orientation couples to both fields. In practice there has to a bit of a compromise, as the shape of the fields means we cannot achieve the ideal.

The position of the transmitting loop is usually going to be around the door as this is a convenient location and it gives a good field. We then have to decide where to put the receiver aerials.

In positioning the receiver aerials, consider the following points.

What really matters is not how big the received signal is, but rather the signal to noise ratio. If there is a local noise source, it is often best to align the receiver to null the noise, not just to get maximum signal.

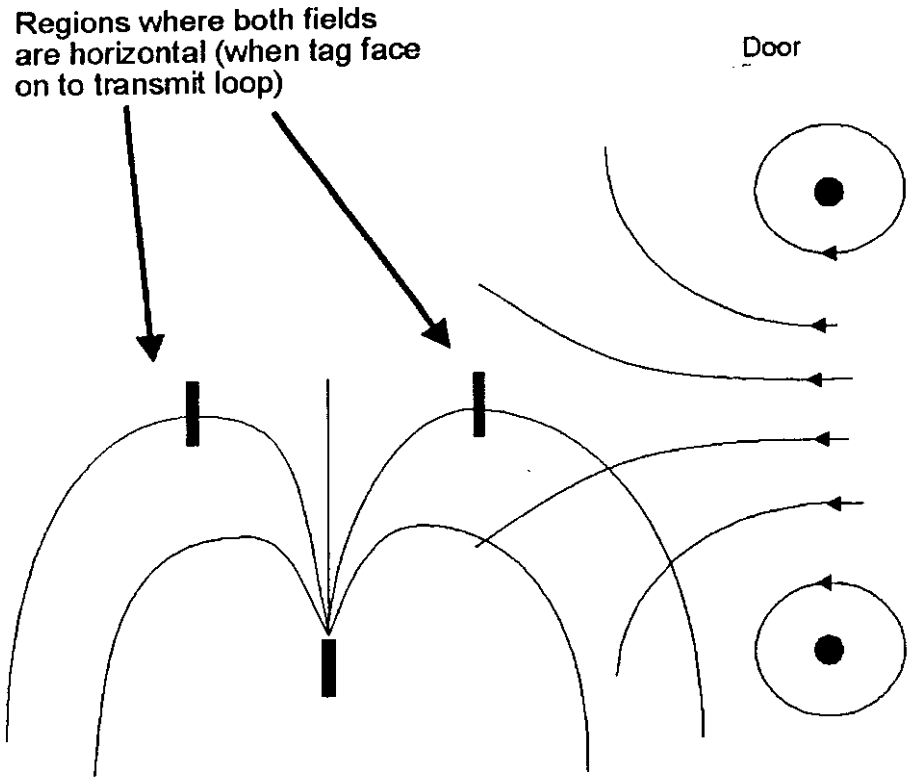
Combining the output of a second receiver pod can improve detection, for instance by providing for those tag orientations that the other pod misses. The danger is

When checking a possible location for receiver pods, do not rely on a normal Site Survey Meter (MS2) which won't be sensitive enough. If you have reason to suspect that there is noise present, there is a special Site Survey Meter based on a receiver pod, which is more suitable.

H.3. Selecting the location (examples)

The most common use of separate receivers will be when a "dual aerial" software option is wanted, but there is nowhere practical to fit two large loops. A single transmitter loop is located around the door, creating a large transmitter field. The receiver pods are located either side of the door, to detect people as they approach the door.

It has been found that the best results are obtained by having the receiver pods set vertical in the ground, even though that places the sensitive axis of the pods at right angles to that of the transmitting loop. The field from the transmitter loop is largely horizontal, and the field from ferrite rods is also horizontal at a distance of a metre or so from where the pods are located.



Here we have a loop around the door creating its magnetic field, and we can also see the field that would be created by the vertical ferrite rod. In the regions shown, the optimum orientation for TC1 tags is vertical, and face on to the door. There will be another pod on the other side of the door.

The pods should be vertical, in the floor, at about 1.5 metres from the door. The receiver pods can detect tags at up to 4 metres, but 2.5 metres is usually a more realistic range (from the pod itself).

A separate receiver aerial may also be used when a single loop aerial might be likely to pick up too much noise. Here there are several options for locating the receiver pod(s).

In the centre of the transmitting loop, with the sensitive axis pointing outwards. (Not usually practical for a door, unless a flat loop is used.)

Vertical, either in the floor in the middle of the door, or above the door. This will detect tags as they approach the door.

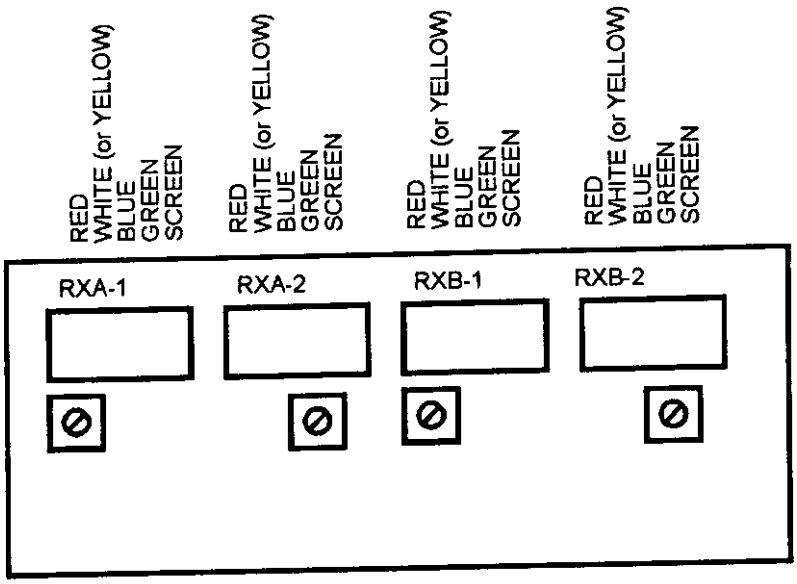
Horizontal and pointing along the direction of travel, above or below the centre of the door. This gives good detection in the doorway itself, so is more relevant to tracking applications than access control.

A pair of pods can be placed either side of the door. They can be vertical or horizontal (along the direction of travel) as required. The outputs are combined, giving good detection, but care is needed to ensure neither is picking up excessive noise.

H.4. Installation

CR1-DS1 readers have a single standard Aerial Module. This is wired to the transmitter loop (usually around the door frame) in the normal way.

The receiver pods are wired into the Receiver Multiplexer board. There are 4 sets of connections, to allow for two pairs of receiver inputs for each side.



The four sets of connections are referred to as RXA-1, RXA-2, RXB-1, RXB-2. If the reader is just detecting tags, regardless of direction (a standard reader), only the RXA inputs should be used. A single pod can be connected to either RXA-1 or RXA-2.

Where the reader is doing direction sensing (control, tracking etc.) the inputs from one side (entry) go to RXA, while those for the other side (exit) go to RXB.

There is a gain control potentiometer for each receiver pod. For unused pods, this should be turned to minimum. Where a pod is fitted, the potentiometer should be turned down until the range starts to drop. (This minimises the effects of external noise.)

If both RXA (or RXB) connections are used, best performance will usually come if they are each contributing similar noise levels. This may be relevant if one side is noisier than the other. Check the range from each of the two pods separately (either removing the other pod, or turning its potentiometer right down). When both pods are connected, you may find that the one which had the better gain has deteriorated. This shows that the other pod is contributing excessive noise. Options are

Turn the gain of the noisy pod down, until the reading range of the good pod is reduced by less than 20%.

Try to rotate the noisy pod until the noise is reduced. (This needs an oscilloscope.)

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