CRYPTAG® CENSUS®

CR1 APPENDICES

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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 <u>should not</u> 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.

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APPENDIX A TECHNICAL DATA

This is an Appendix to the CR1 Tag Reader manual. The general principles outlined herein apply to other reader types in the Cryptag Census Range

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 in the interrogation field of the Reader, 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 within range, and only those tags addressed are authorised to respond. The ability to read many tags at once is referred to as multiple reading.

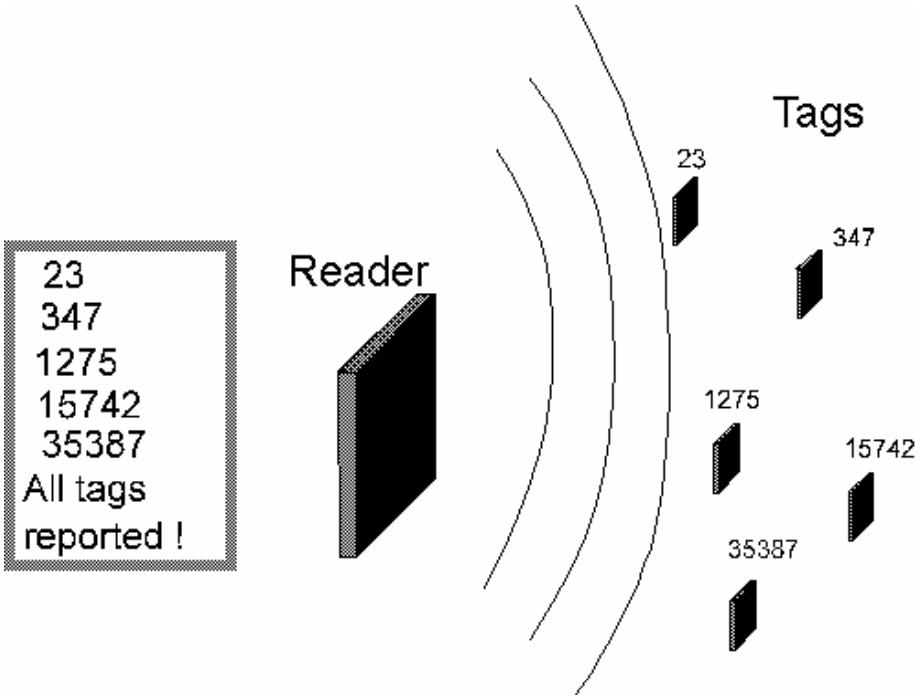


Figure 1

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 CR1 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 (see figure 2).

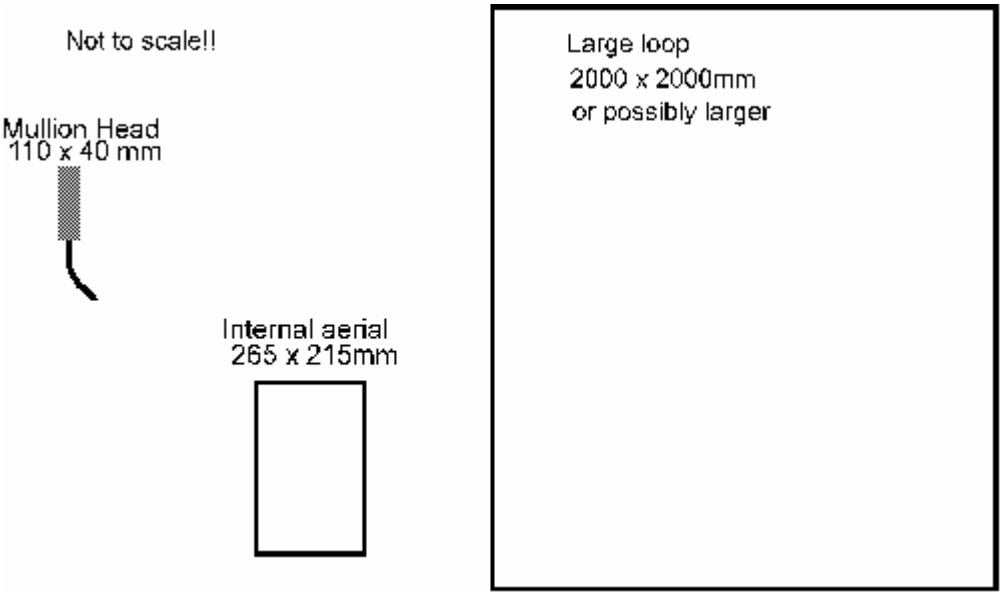


Figure 2

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, MS3 (in USA MS3A). **(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, e.g. (see figure 3)

CR1 reader with internal aerial	1.2 metres
CR1 reader 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 in figure 3, which applies to Tags TC1, TC2 and TC6.

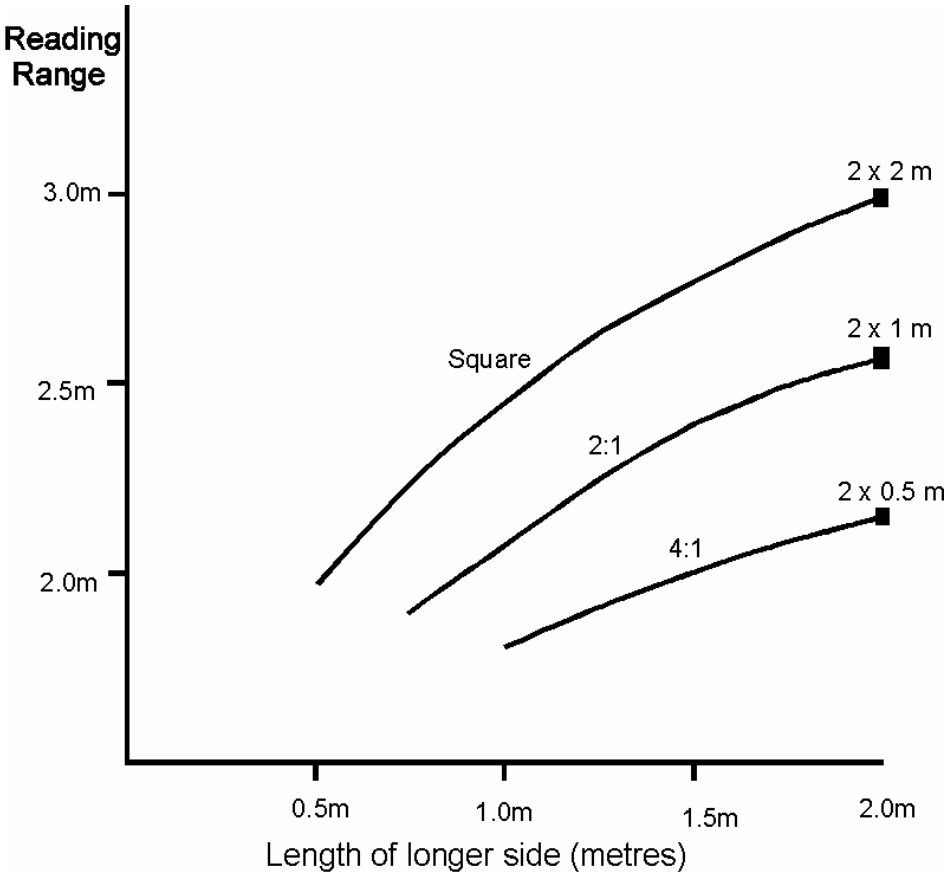


Figure 3 - Graph of reading range against loop size (single turn)

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.*

Other tag types. In all cases the version for USA use has the letter 'A' attached to the name.

Type	Dimensions (mm & inches)	Weight	Colour/Material	Battery life	Range (vs TC1)
TC2 Article tag	56 x 76 x 6.5 2.3x 3 x 0.25	30g 1oz	Black, cream, or grey ABS epoxy filled	as TC1	100%
TC3 Article tag	---------- as TC2 ---------- (Only suitable for mounting on metal. The optimum orientation is not the same, but is rotated through 90 degrees.)				90%
TC4 Keyfob tag	42 x 54 x 17 1.7 x 2.1 x 0.7	15g 0.5oz	Black ABS	Replaceable	66%
	(The TC4 has a removable battery. Weights are without battery.)				
TC4S Robust KeyFob tag	42 x 57 x 12 1.7 x 2.2 x 0.5	30g 1oz	Black/Grey ABS GRP	as TC1	66%

TC5	38 x 46 x 9	25g	Black ABS	Replaceable	50%
Wrist tag	1.5 x 1.8 x 0.3	0.4oz			
	(The TC5 has a removable battery. Weights are without battery.)				
TC6	95 x 64 x 5	18g	ABS	Replaceable	100%
Cliptag	3.7 x 2.5 x 0.2	0.7oz	Various Colours		

A.5 Electrical connections, and interface

CR1 Cryptag Census readers have 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 in main manual.

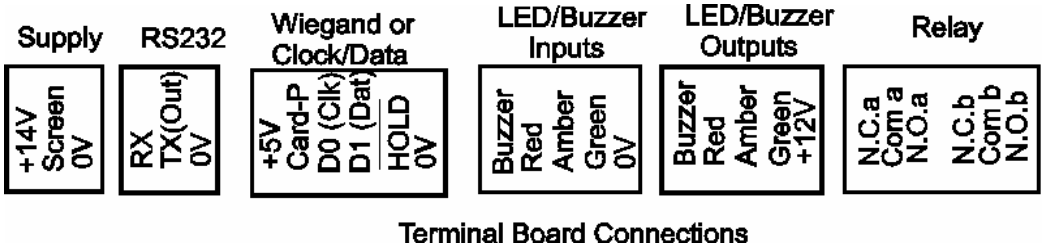


Figure 4

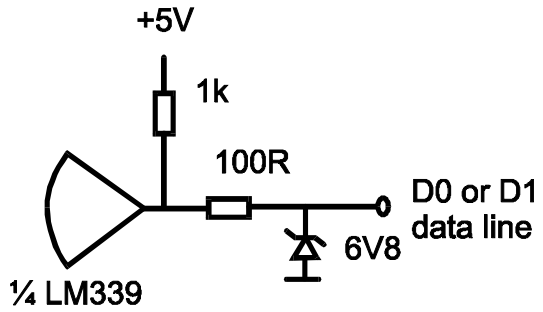
Power see Section A.6 (below)

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 250ms delay.
Wiegand format, and timings are determined by software version.



Wiegand output circuit schematic

Figure 5

#Software options can affect performance.

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

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Hold line can be used to make the reader cease transmitting Wiegand data. If this line is pulled low, the reader will complete the transmission, but will not start again until Hold goes high again.

#The Card Present line is used with Clock/Data output format readers, and goes low while tag data is being transmitted.

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.

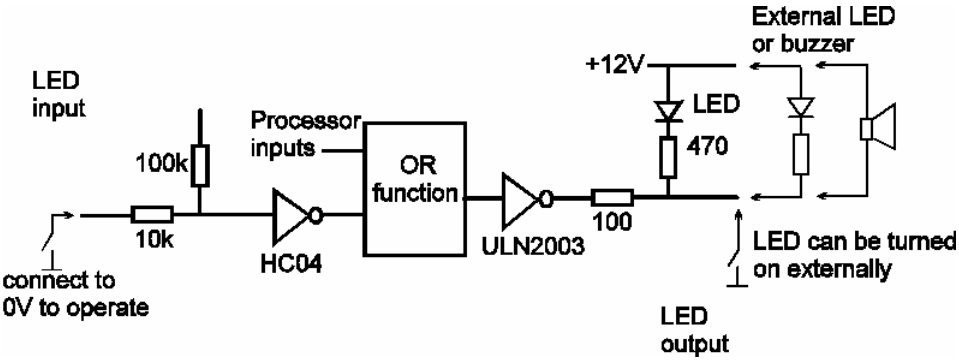


Figure 6

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 can 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 and that it is properly decoupled to minimise effect on power lines.

#Software options can affect performance.

The maximum peak 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.

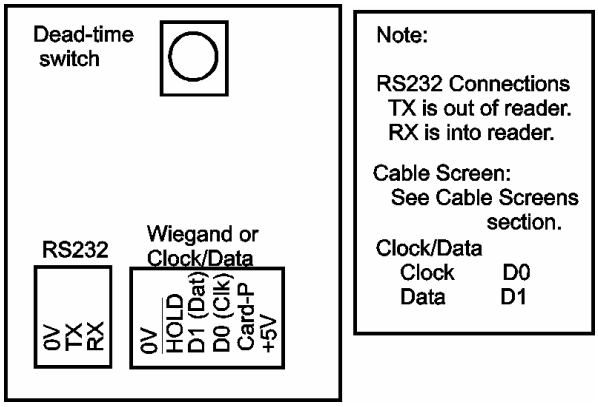


Figure 7

External Aerials (Primary or optional second aerial module)

The CR1 reader is fitted with an internal aerial loop, but this can be replaced by an external aerial (as on most variants). 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 Power to CR1 readers

CR1 readers require a dc power input which is nominally 14V. The minimum voltage is 12V, and the absolute maximum is up to 26V. Where the current consumption of the reader is above about 400mA thermal considerations mean that the maximum voltage should be reduced, otherwise the reader will lose range dramatically.

Current drawn	Maximum voltage
400mA	26V
500mA	23V
600mA	21V
700mA	20V
800mA	19V

The current consumption of a basic CR1 reader is typically 200mA with an internal aerial. Additional PCB options increase the current. The data following gives a realistic estimate of current for each module.

Aerial Modules.
The extra current depends on the configuration and whether all of the modules are actually transmitting. A basic Aerial Module takes 50mA typical (approx. 60mA max.) if it is not transmitting. The current drawn when connected to an aerial loop depends on the Q of the loop and how well it is tuned. A well tuned loop will take 30mA or less. Readers intended for use with external aerial loops are fitted with a small internal ferrite aerial for initial setting up only. This has a poor Q and takes about 130mA. Remember that a properly tuned loop takes minimum current but has maximum range.

In some configurations of DS readers and readers with multiplexed aerials, not all Aerial Modules are transmitting at any one time. This should be taken into account.

Master/Slave
The Master/Slave option adds about 16mA, but in this case both loops connected will be transmitting.

Aux. Comms Board
The Aux. Comms Board is used with DS readers, and takes about 12mA.

Internal LED display
The majority of the current consumption for any LED display is in driving the LEDs, and is therefore proportional to the number of segments which are on. At maximum intensity the worst case (88) is about 220mA, but as it is more normal to show a single digit the maximum is about half of this. Turning the intensity down to minimum also halves the current taken.

Multiplexer
The Multiplexer board's own current consumption is relatively small, and is unlikely to be significant in comparison with what is taken by the PCBs attached to it.
The Multiplexer has its own power input, which can be used to avoid the risk to thermal problems. For advice contact Identec.

A.7 Operating Environment

Cryptag Census readers are guaranteed to operate over the temperature range -20^{o}C to +60^{o}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.8 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 from others.

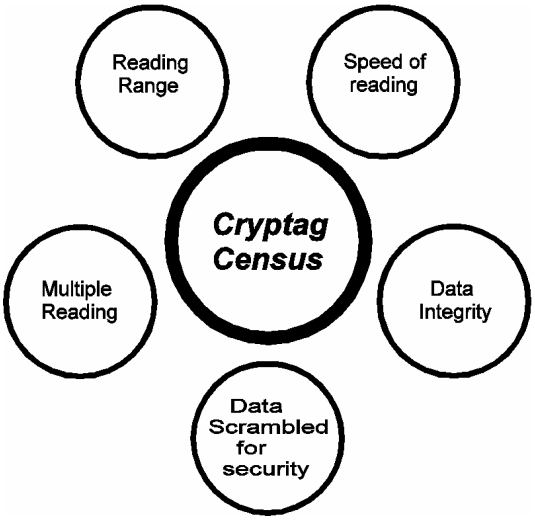


Figure 8

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, pseudo-randomly 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.9 Speed of reading

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.)

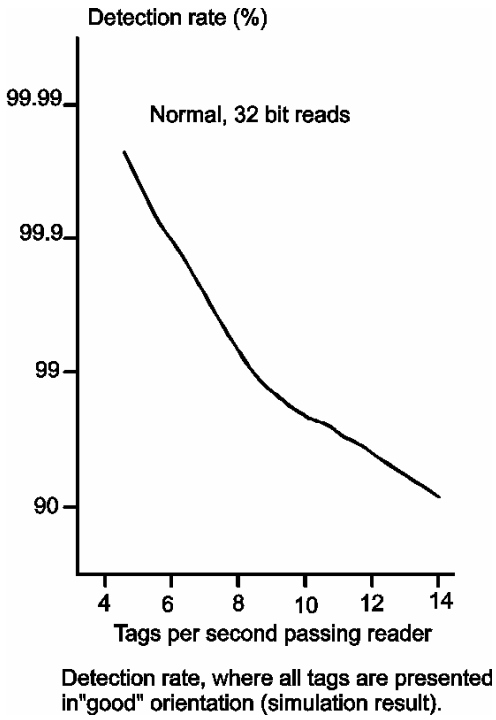


Figure 9 (worst case simulation)
(Note: USA readers will achieve slightly higher reading speeds.)

A.10 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 change their scan frequency depending on the resolution. The other variable is how well screened the monitor is. Some monitors will reduce the reading range of Cryptag Census when the monitor is at a distance of 3 metres (10 feet) or more from the reader. 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 (receiver) 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 some Low Voltage lighting systems that generate high emission levels in their "transformer" module, which actually contains a switch-mode converter. The “electronic transformer” can be screened using aluminium sheet. (Good results have been achieved using 0.5mm aluminium sheet. Perforated material also works.)

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 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.11 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.

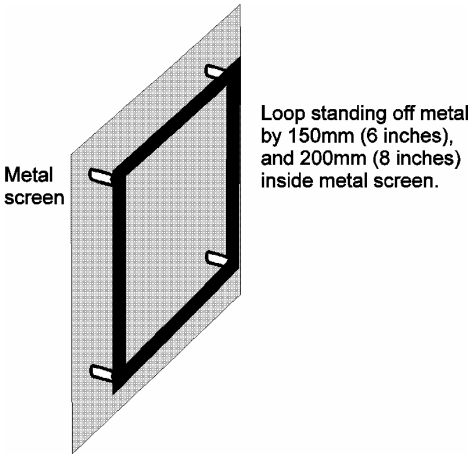


Figure 10

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 -20ºC to +60ºC.

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

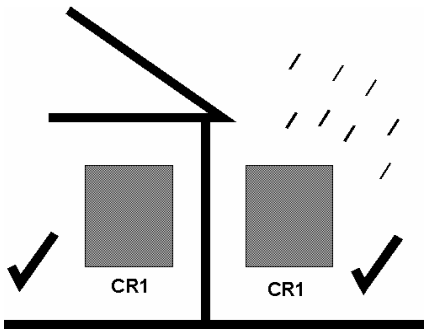


Figure 11

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. (Figure 3 on page 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

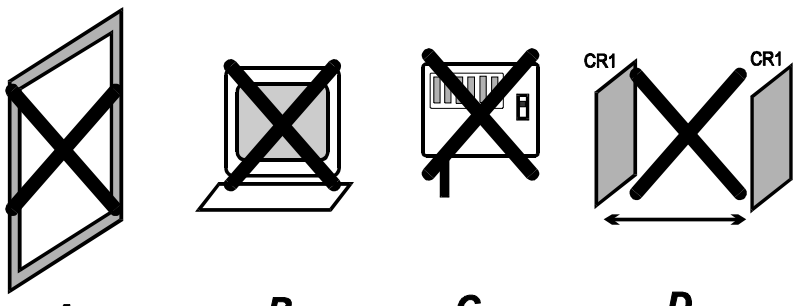
Before deciding on a reader configuration and position, make sure there isn't something that will stop it from working.

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 Tuning and Noise Meter <u>MS3</u> (or in USA MS3A). Make sure that possible sources of interference are turned on.



Metal Loop **Monitor** **Photo Copier** **Other Census Readers**

Figure 12

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 Noise Meter. If possible have the plane of the loop at 90^{o} 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 the reader manual.

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.

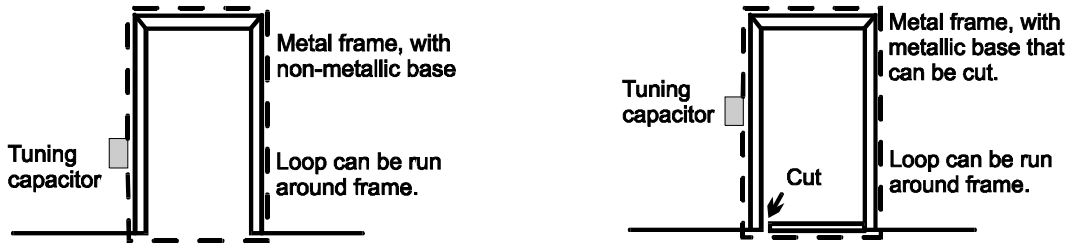


Figure 13

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.)

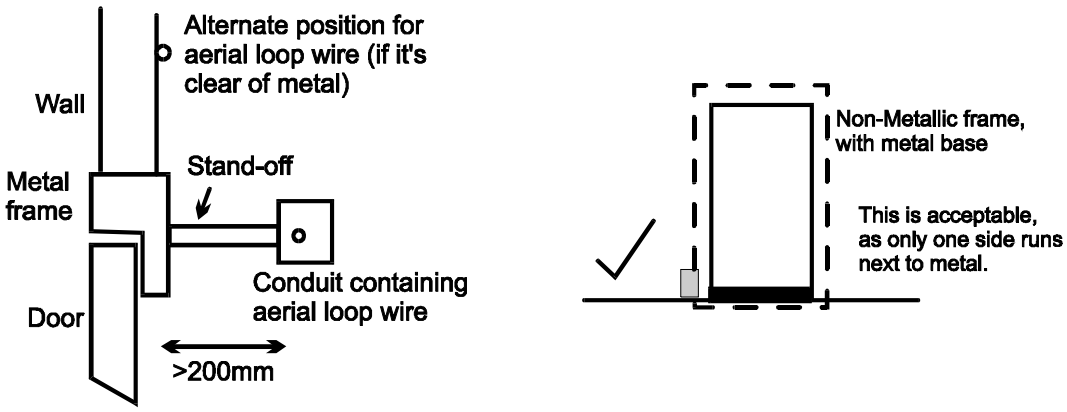


Figure 14

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.

C.1 Data output

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

C.2 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.

C.3 Direction Sensing (CR1-DS, CR1-DS1 etc. hardware)

Control version.
Tracking version.
Safety version.

C.4 Dual reader (CR1-DS hardware)

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

C.5 LED and Buzzers

Regular beeps when a tag is "loitering" near the reader (reducing 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. They use CR1-DS hardware which has a second Aerial Module, or CR1-DS1 hardware which allows for separate receivers.

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.

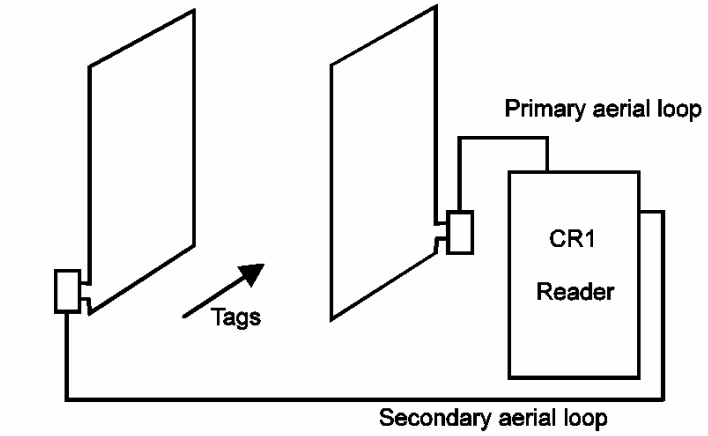
As one reader is reading tags at both aerials, the rate at which people can pass through is determined by the total traffic in both directions.

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.

Figure 15

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

to suit the application. The loop should cover enough of the width of the roadway to be sure that the tag will pass over it, and the length along the road will depend on the likely 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.

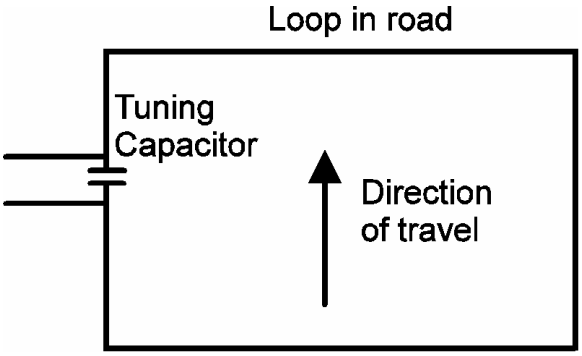


Figure 16

TC2 tags can be used if they are not going to be mounted on metal. If the tags are to be mounted on metal TC3 tags should be used(but must be mounted on metal).

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.

D.8 Figure of Eight Loops

There are situations where it is advantageous to make the aerial loop into a “figure of eight”. Tags reading close to the aerial is about the same as a normal loop, but the field drops off more quickly. This also means that interference from a distant source is cancelled out, but sources of interference near the reader will have the same effect.

The figure of eight aerial is most likely to be a large aerial placed in the ground. Care must be taken to ensure that there are no metal structures underneath it (see Appendix J). A large aerial picks up more background interference, so the cancellation provided by a figure of eight is advantageous.

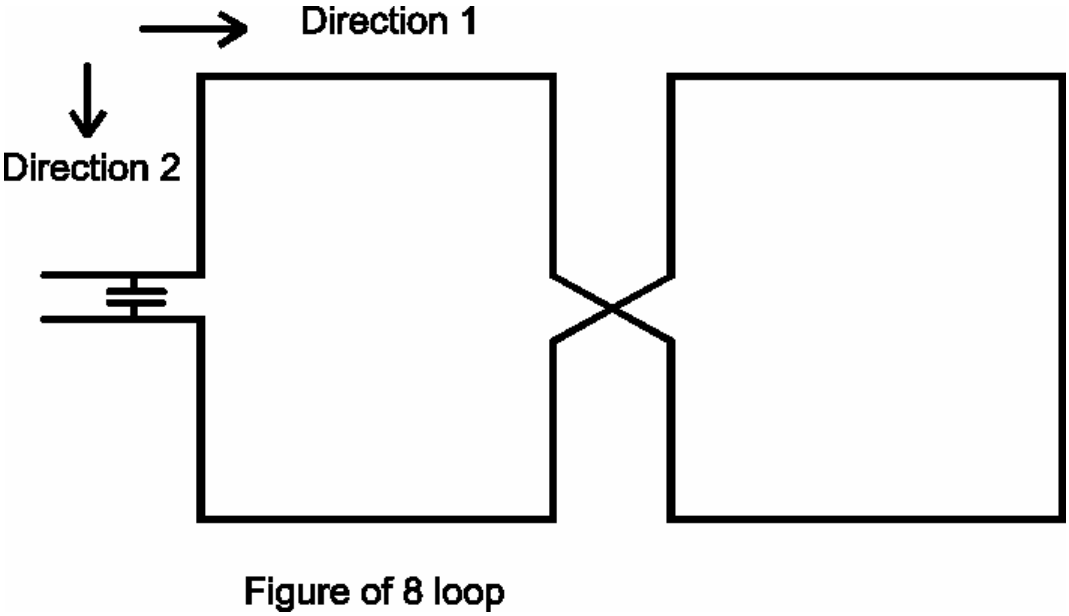


Figure 17

One possible use is when tags are being carried on the person, and the aerial must be in the ground. The aerial should be arranged so that each half of the eight is about 2 metres square, and people pass over it travelling in Direction 1. The strongest field is over the two parallel conductors, where the reading range should be about 1.7 metres. It should be noted that the best orientation is when the tag is worn on the front. The range is only just adequate for tags worn on the body, so trials are recommended. (Fortunately when tags are worn on the side they are also worn lower down, so the detection probability should be maintained.)

Another possible application of figure of eight aerials is for vehicle mounted tags. Here it is more likely that tags will be travelling in Direction 2. The figure of eight configuration will help if noise is a problem. There will be a dead spot in the middle of the aerial, and ideally it should be arranged that tags cannot pass over this region. Alternatively two figure of eight aerials can be used in Master/Slave configuration, with both aerials in the ground, and overlapping each other (and displaced in both directions).

D.9 Separate Receiver Pods

The aerials on a Census reader can be separated, so that the transmit aerial is in one place and the receive aerial is elsewhere. The receiver pods are typically 200mm (8”) long and 20mm (0.8”) diameter.

BENEFITS

Direction sensing through a doorway is often easier to arrange. It is not always practical to have large aerial loops on either side of the door, but it is practical to have a loop around the door with receiver pods on either side of the door. The receiver pods can be placed in the floor about a metre or so either side of the door.

There may be a localised source of noise which affects a loop around a door. A small separate receiver can be placed away from the noise, but still pick up signals from tags activated by the transmitter loop.

More than one receiver pod can be used, and their signals combined electronically. (Of course the noise is also increased and it is best to ensure they have similar noise levels. If one is picking up much more noise than the other, performance may be improved by switching off the noisy receiver.)

DISADVANTAGES

A tag is only read if it gets a good signal from the transmitting aerial, and the receiver aerial receives a good signal from the tag. Both of these are affected by orientation. With a single aerial for transmit and receive the tag only has to have the right orientation for this one aerial. With a separate receiver, the orientation has to be correct for both aerials. There are more "dead-spots", and detection probability is less.

D.10 Multiplexed aerials

A single Census reader can be made to control a number of aerials using a multiplexer. Each aerial is looked at in turn, to see if there are any tags present. This can be used to cover an entrance which is too large for a single aerial (or Master/Slave). As long as any of the aerials can detect the tag it will be read.

As the aerials are checked sequentially, the reading rate is reduced, and this is not suitable for a high throughput application. The order of scanning can be modified so that some aerials are checked more frequently than others.

Multiplexed aerials can be combined with other hardware options.

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

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 9001:2000. (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. Tags should not be left close to CRT computer monitors or similar equipment.

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, or on a computer monitor.

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.

Appendix H Aerial installation - advice to contractors

This appendix covers the installation of aerial loops in the ground and the positioning of wiring near the aerial location. It includes instructions to ensure that the risk of unwanted interference is minimised.

The wire used for ground loops should be suitably resistant to corrosion and heat (e.g. 4A BS 6195 Type 4A 1.5).

These instructions should be given to the relevant party before any work commences.

H.1 Concrete under the aerial loops

The performance of readers can be affected by metal under the aerials, and this includes reinforcing steel. The metal can affect the performance in two ways.

Firstly any metal (ferrous or non-ferrous) can form closed loops which suck energy out of the reader's transmitter. Examples of possible closed loops include reinforcing mesh and rods which are tied together (directly or with wire) to form a complete loop. Any such closed loop should be at least 200mm away from where the aerial loop is to be placed. (This might be relaxed for some aerial configurations, but only after discussion with Identec or the local equipment supplier.)

The other way in which metal can affect readers only applies to ferrous metal. The signals from the tag are high frequency magnetic fields and a magnetic material can channel interference from one place to another. The interference will be concentrated around the ends of rods and the edges of sheet or mesh structures. Such ends and edges should be at least 500mm outside the intended aerial location.

DO
Put all reinforcing at least 200mm away from where the aerials will go.
Make sure that any reinforcing is continuous across the whole of the intended aerial location, and extends 500mm outside it.

DON'T
Have any metal structure within 200mm of the loop location. (Although small items for fixing are acceptable, as long as they aren't within 100mm of the reinforcing.)
Have any ends or edges of reinforcing rods under the loop.

H.2 Wiring near the aerials

Some electrical wiring can produce interference in the frequency band used by Cryptag Census readers, and it is best to keep such wiring as far away from the readers as is possible. Interference can only be caused when there is a loop (with a significant area) caused by the wiring, so if wiring must be taken near the readers some simple precautions are advisable.

Interference is caused by high frequency currents flowing in the cables. As long as the current into the wire balances the current out of the wire there is no net current and therefore no significant magnetic field at a distance. Problems arise when there is an imbalance current, often because there are earth loops.

Wiring to a single point (such as a mains socket) is acceptable because there is no separate return path. There should be no additional connections, such as earth bonding. If a metal backbox is grounded using the cable earth it must not be electrically connected to any other metal structure which could be earthed.

If there must be a loop of some sort (e.g. ring mains, access control bus, or fire alarm loop) the wiring into and out of any unit in the vicinity of the reader should follow the same path. Once again there should be no other electrical connection at the unit concerned.

It is difficult to give hard and fast numbers on the likely “safe distance” for cables, because some electrical equipment is extremely noisy. In the worst case we have seen equipment that produces interference that affects Cryptag Census readers at distances of over 10 metres. Fortunately this is the exception rather than the norm. The worst case is for a cable which is part of a loop, where the return path is a long way away, and such cables should ideally be many metres away from a long range aerial. A single spur, or a loop with its return path should be at least 300mm from the reader cables.