iX5 - Series

Long range Anti-collision Reader for EM4001 Cards

Contents

1. Overview

The **iX5** is a state of the art 125 kHz RFID *anti-collision* card reader intended for production, process, logistics and access control and reads ID-Innovations programmed EM4001 compatible cards. The **iX5** has very long read range and it is fast, very fast. It can read 3 equidistant cards at a distance of 80cm in 36mS. The **iX5** is radically different from all conventional 125 KHz anti-collision readers. It reads cards by looking at the sum contributions of *all* the cards in the field and uses waveform analysis to determine the individual contribution of each card. This allows it to read cards blazingly fast, literally simultaneously. Note that the term 'anti-collision' reader has been used because this is widely understood to be a reader which has the ability to read several cards in the field at the same time, although strictly speaking the ix5 would be more accurately described as a 'collision' reader because it reads cards whose data is in constant collision with data from other cards.

The **iX5** has major advantages over other anti-collision readers in areas of cost, read range, speed and versatility; it uses the ubiquitous EM4001/EM4100 format so it can simply and economically integrate with many other office/factory systems.

The **ix5** is now trialing hosting using polled commands. The polling can address several thousand readers although in practice one hundred readers would be reasonable. Each reader has two remotely controlled power drivers for two independent 12volt strikes and a door open/closed sensing facility.

2. Features

- ✓ **Long Read Range up to 100cm**
- ✓ **Reads 6 Cards simultaneously**
- ✓ **Easy integration into office systems.**
- ✓ **Uses Standard EM4001 Format**
- ✓ **2 Remotely Controlled Strike Drivers ***
- ✓ **Very Fast reading**
- ✓ **Inexpensive cards and readers**
- ✓ **Ideal for logistics.**
- ✓ **Polling system for multiple readers.***
- ✓ **Remote Door Sensing ***

*** Implemented, but currently undergoing trialling/beta testing.**

3. iX5 Technical Overview

The **iX5** system uses high speed algorithms (Patents applied for) to analyse the combined waveform of several cards and determine their individual contributions and thus their ID. The **iX5** can literally read 3 cards in the space of a single card's data transmission cycle of 32mS, plus processing time. Three cards can usually be processed in the minimum time of 32mS required for the card data transmission plus RS232 transmission time. In common with other systems, factors such as noise can degrade these figures. The **iX5**'s built-in anti-interference algorithms reduce the effects of most industrial switching noise.

As the number of cards rise above 3 the time to process the cards escalates rapidly, even so the **iX5** will normally read 6 equidistant cards in about 450mS. Read times can also be affected by range. Eventually, waveform complexity, noise and saturation effects limit the maximum number of cards that can be read. Twelve cards have been read although no claims are made in respect of this or for the read time required.

4. iX5 Advantages over Contemporary Anti-collision Readers

The **iX5** is fast. To gain a measure of the efficiency of the **iX5**, consider that normal EM4001 readers need to read each card 3 times to verify the data and this requires about 100mS. The **iX5** is fast because it is not bound any such limitation and can typically read *three* cards in about 36ms, that is about 9 times faster than a standard reader for 3 cards and about 3 times quicker for a single card. (Times not including RS232 transmission time)

Bus-pass logging is an application that benefits greatly from anti-collision technology. Ordinary readers may be used, but their use is restricted because they have to be placed in special areas away from other cards and this can be difficult. The **iX5** is not disabled by seated or standing passengers with cards. This means the reader can be placed where it is most convenient.

The typical anti-collision systems send commands to the cards to manage the data, or alternatively wait for each card to randomly transmit it's ID. There is a high overhead associated with both methods. The conventional random type anti-collision system can take several seconds to read each card whereas readers that send commands to cards are doubly penalized, by both by the reader to card communicates which can be time consuming and by the crippling loss of range associated with the difficulties of long range communication with the card.

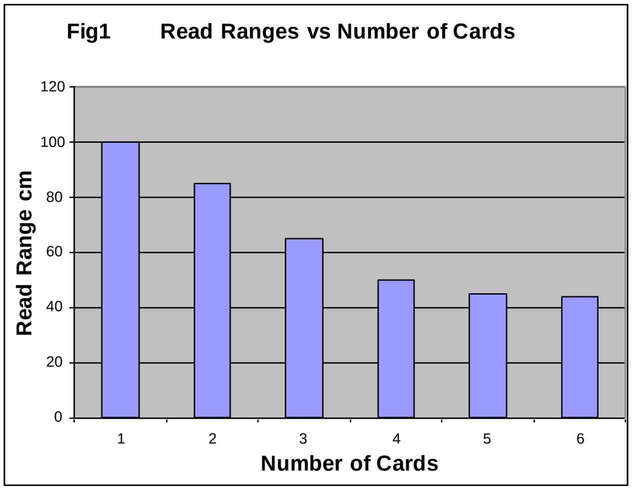
Most anti-collision readers are therefore slow. Anti-collision readers that employ binary tree analysis have their speed limited by a heavy reader-to-card communications overhead and once again, they suffer from low range because of inherent reader-to-card communications issues, and they require large power RF drives.

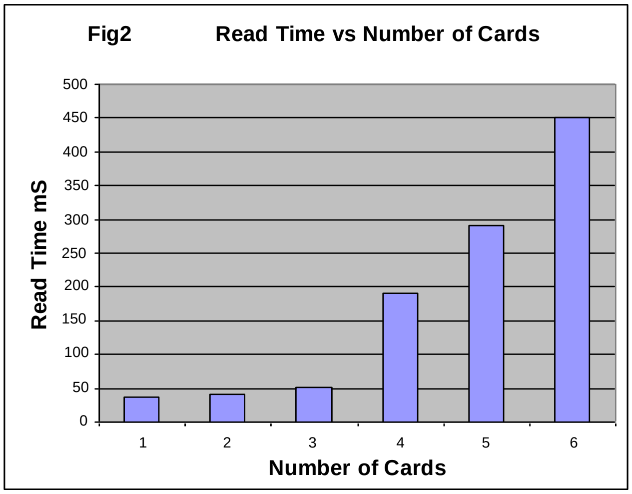
Apart from the speed and the range, conventional anti-collision systems have a third major disadvantage; they use specialist non-standard card formats causing integration problems with other systems.

Most anti-collision readers are expensive because they are over complex. It is difficult to design readers that send commands to tags because although the transmission circuits are simple, the receive circuitry is not, in fact it is made especially difficult by the vast changes of signal at the antenna caused by the communications. The bottom line is *mos*t anti-collision readers are hi-tech and comparatively expensive.

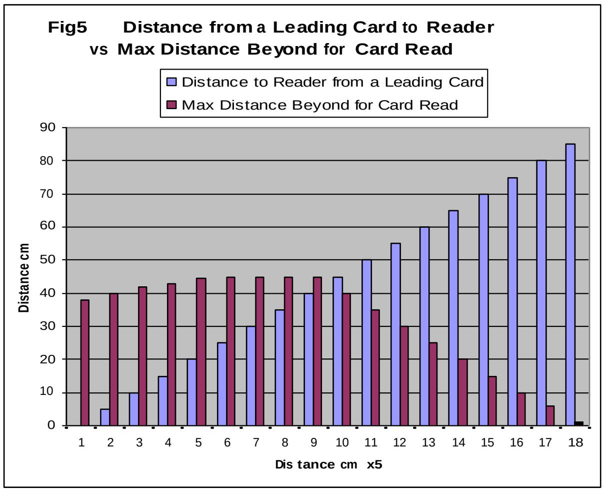
The **iX5** uses standard EM4001/EM4100 compatible programmed cards supplied by ID-Innovations that can be read on any normal EM4001 card reader. This allows a mix of anti-collision and 3rd party non-anti-collision readers. If a plant or process or bus pass system has an anti-collision requirement then only the part that actually needs the anti-collision function need be upgraded, avoiding costly and intrusive total upgrades and minimising or eradicating down times altogether.

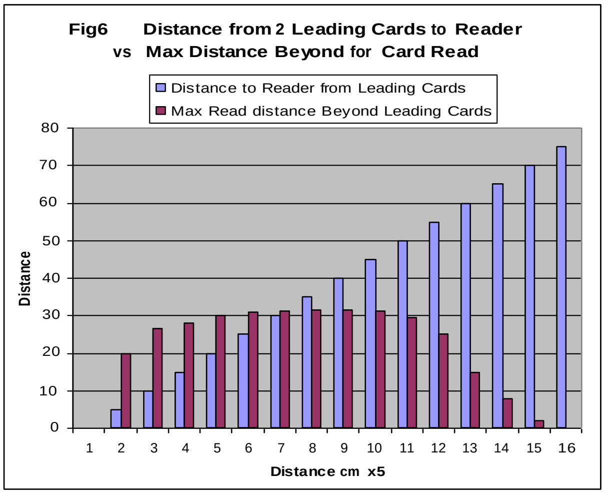
5. Read Ranges and Read Times

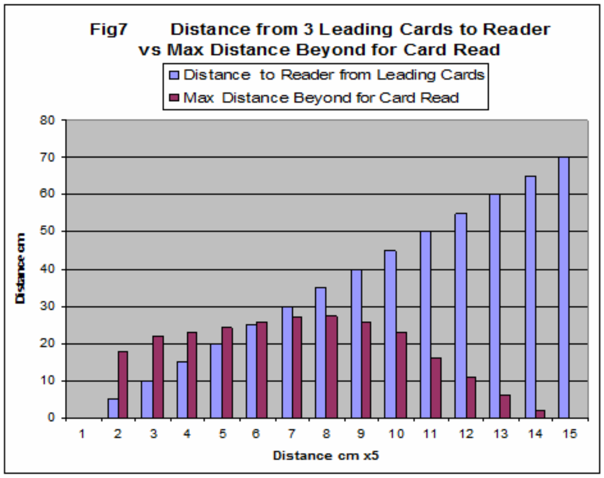




Read times and read ranges are linked with the number of cards in the field. The range for a single card is in the order of 100cm. As more cards are introduced into the field the range tends to decrease and read time increases. This is the result of background noise and the increasing complexity of analysing the received signals. The read range for 2 equidistant cards is in the order of 80cm and a typical read time is 45mS. When 3 equidistant cards are place in the field the read time is still very fast, however the complexity of the analysis means more time is required and the average read time rises to around 50mS. Other factors such as switching noise can increase this figure. As the number of cards in the field rises above 3 the processing time required rapidly escalates. The reader will normally read 6 cards in about 450mS (not including RS232 transmission times).







In access control it is likely that the cards will all be at different distances from the reader. The above graphs show configurations for 2, 3 and 4 cards in the field. In the two card condition it can be seen that when the two cards are equidistant the range is over 80cm. As a leading card approaches the reader and is at 50cm from the reader, a 2nd card can still be read that is 35cm behind it, in other words at over 80cms. As the lead card is 30cm from the reader the more distant card can read at a distance 45cm behind it or at 75cm.

RS232 communications can introduce switching noise so the **iX5** spaces out the communications to give itself an opportunity to read fast moving card that transiently pass through its field. A baud rate of 19200 is a good compromise between speed and cable length, however, it means that each data package is 8mS. The card data is sent out every 45mS. For the vast majority of applications this is not a limitation.

6. Using the iX5

The **iX5** is most effective when all the cards are equidistant from the reader. Up to 6 cards can normally be read in about 450mS if the cards are stationary and about 350mS if the cards are moving, even if grouped, but cards should not be placed directly on top of each other as this will prevent the cards from operating correctly. Innovations make claims for 6 cards although more may be read, however as more cards are included in the field it becomes increasingly important to ensure that all cards are equidistant from the reader to make the signal analysis easier.

For process lines in particular it should be noted that, the nearer the cards are to the reader, the more robust the reader becomes in a noisy environment, however the reader may be desensitised if several cards are placed permanently up or against the iX5 case because the high degree of coupling can temporarily detune the **iX5** antenna and also cause signal saturation. The reader will still read the cards near the reader but may become less sensitive to more distant cards.

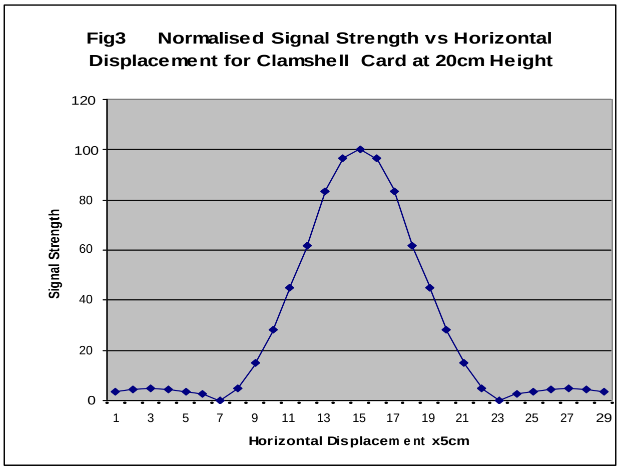
The best working environment is where the cards are equidistant from the reader, however situations may arise where this is not possible. The **iX5** also has exceptional dynamic range and in a two card situation can determine a second, more distant card, even if the signal strength is 1/30th of the card nearest the reader. Practically this does not mean the 2nd card can be 30x further from the reader than the first card, it actually translates to a maximum difference in spacing between the nearest and furthest card of about 40cm for dual card reading.

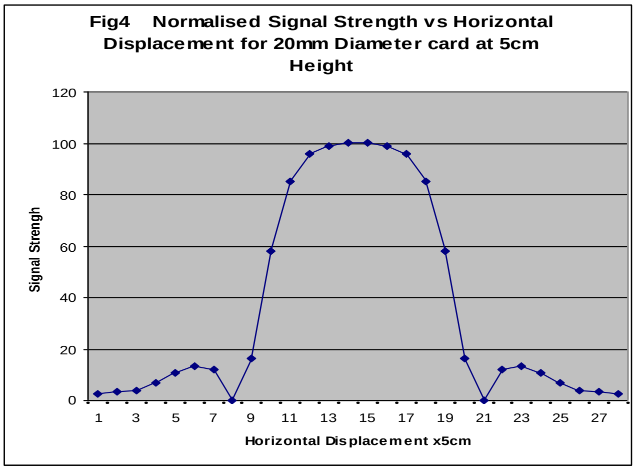
In access control applications it is debatable how many people can approach a reader at any one time. Assume an extreme case where 20 people converge on the access control reader. In the real World it is unlikely to happen, but allow that it did. The way people present their cards normally ensures that at any moment in time there are always 2 or three cards nearer the reader than any others and will be read and it can be argued that eventually all will be read.

In fact anti-collision readers for access control are usually not used to give actual access but to log people in or out including such applications as bus passes for school, senior citizens and special groups. In these situations the reader is used for accounting purposes. Readers rarely get 3 or 4 cards in range simultaneously. In this application the iX5 is ideal because it can be mounted where it is most convenient. It can even be mounted close to seated passengers who themselves may have cards. Normal readers just cannot cope with this situation because they can be compromised by a just single stray card forcing the user to place the reader in a restricted position.

The upper limit for the number of cards that can be read in the same field has not been tested. We make no performance claims in this respect but as many as 12 cards have been read and this seems to be a practical upper limit, however, the read time may get very protracted. The reader may still be usable in applications where read time is not a factor.

The iX5 has 2 independent door strike strikers that can be remotely activated. The second strike is primarily intended for industrial process lines. The iX5 also has door sensor connectivity. The commands to activate the strikes and read the door sensor are built in to the polling system but can also be used in normal non-polled use. The on-board strikes contained in the reader can reduce or eliminate the requirement for a local controller when used with a host computer making the system both less expensive and less complicated.





The number of cards in the field can be increased if the cards are moving. Consider an application where 20 or more cards are spaced out near the reader. The best card signal is obtained when the card is at a normal to the reader. At an angle about 45 degrees of the normal the signal from the card is significantly reduced and goes through a null point. This has the effect of singling out the cards near the normal to the reader, it is in effect, a bit like a torch beam. With reasonable card placing the reader can face many cards but only a few are in a position within the 'torch beam' to be read. This is ideal for such applications as conveyors where robust card reading can be obtained even with extraordinary high conveyor belt speeds.

7. Cards/Tags

The reader uses cards available from ID-Innovations. The cards are programmed to EM4001 format and can be read on any other EM4001 type reader. Third party supplied EM4001 format cards will be read but the reader will not behave as an anti-collision reader and the reading speed will also slip. If a mix of Innovations supplied cards and 3rd party cards are presented to the reader the reader will continue to read the Innovations supplied cards in anti-collision mode but the 3rd party card/s may not read. ID-Innovations may entertain requests to program 3rd party supplied cards.

For further information contact help@ID-Innovations.com.

8. Installation

Position the **iX5** away from sources of interference such as mains wiring. Do not fix the reader antenna on solid steel objects or range loss may occur and the auto-tuning may run out of range. Moderate metal fixtures are acceptable.
Do not mount the reader on an uneven surface as the reader will become mechanically stressed by the fixing screws. Do no place in an area with vibration because this can cause loss of range. Do not place within 2m of another **iX5** or 15m of any other 125 KHz reader or loss of range may occur.

Use a 1 amp regulated Power Supply. Switching regulators may be used but the devices should preferably be separated from the reader to prevent interference.

9. Device Operational and Physical Characteristics

Parameter	Conditions
Power Requirements	11-13 VDC at 0.75 Amperes nominal
Read Range for 6 equidistant cards	55cm - 60cm (Innovations Long Range Clamshell Card)
Read Range for 3 equidistant cards	60cm - 75cm (Innovations Long Range Clamshell Card)
Read Range for 2 equidistant cards	80cm - 100cm (Innovations Long Range Clamshell Card)
Read Range for 1 card	95 cm - 110cm
Transponder	Innovations, EM4001 compatible, Manchester encoded
Auto-tune	Internal upon switch-on
Interfaces	RS232 (19,200, n, 8, 1)
Read Indication	LED and Beeper
Dimensions and Weight	22cm x 22cm, 2Kg
Temperature range	-10c to +50c. (Enquire for extended range -20c - +60c)

9.1 Absolute Maximum Limits

Supply Power Voltage (Red Lead)	+18volts. Short term only.
Voltage on Door Sensor (Brown lead)	+/- 200volts for 1mS
Strike Drive (Yellow and White leads)	Max Volts +30volts, -1volt : Max Current 2amps (1 second intermittent only)
Temperature	-20c + 60c

10. LED Indications

The iX5 has three LEDs labelled PWR, READ and AUX.

The PWR LED. This is the power LED and it is controlled by the firmware and activates after switch on. It has dual functions. The primary function is to indicate that the reader is running. Its secondary function is as warning indicator. In certain fault conditions this LED flashes on and off. It can only be reset by powering the reader on and off. Even while flashing, all other reader functions remain active and the reader will still read cards. An error message is sent to the host to indicate the type of warning.

The READ LED. This LED has a dual function. In normal read mode it indicates that a tag has been read and is being sent. In Polled-Only mode it indicates that the reader is sending a transmission. Very short flashes indicate that the reader is answering a polled command and is simply acknowledging that command. A longer, brighter flash indicates that the reader is sending tag data.

The AUX LED. This LED is driven on by strikes1&2 powering on. It is dual colour. Strike1 active is indicated by this LED flashing red, Strike2 active is indicated by it flashing green and both strikes active is indicated by it flashing yellow, ie green + red.

11. Data Formats in Normal Mode

The iX5 transmits using standard RS232 19200:N,8,1 :
(Baud rate 19200 : No parity : 8 data bits : 1 Stop bit)

The normal (non-polled) RS232 data string is preceded by an STX (start of transmission) control character followed by either an 'N' or a 'P'. An 'N' signifies that the card is new, while a 'P' signifies that the card has been previously read and remains in the field. The card ID/Data follows represented by 10 ASCII characters, then a CR (carriage return) control character, an LF (line feed) control character and ends with an ETX (End of Transmission) control character, as below.

STX (02h)	'P' or 'N'	DATA (10 ASCII)	CR	LF	ETX (03h)

12. Report Format

Upon switch-on the reader sends a report via the RS232 line. The report indicates the Software Revision and data for fault diagnosis. A typical switch on report is:-
01/01/11 Andexor Ltd, EM4001 iX5 Anti-Col Reader VER 1.00/003F/1111/8227/0016/09/0060/0032

Note: The fields of the report in future versions may change. Developers are advised to future proof their host software by allowing for changes switch on report.

13. Data Transmission Control Routine

The transmission of card data is organised by a transmission control routine to present minimal work overhead to the host computer/controller. When a new card is read, its card data is given transmission priority over cards that are still in the field and whose data has already been sent so that the new data is usually sent within 40mS of read time. If a card has been previously read and remains in read range, its data is re-sent every 1.25 seconds unless a new card has been read and has priority, in which case its position will drop in the send queue behind new card. If a card is removed from the field for longer than 1.25 seconds, upon re-entry it is once again given priority.
It should be noted that if a controller is detecting the absence of a particular card and there are many cards in the field, the card data may not be transmitted regularly every 1.25 seconds, especially if the card is at extreme read range.
RS232 transmissions tend to interfere with card data reception so the transmission control routine sends RS232 data in packets separated by about 40mS. This gives the **iX5** the opportunity to detect cards transiently passing through the field at the edge of detection, transmission control routine.

The net result of the transmission controller is to minimise the work overhead for the host computer while maintaining read efficiency for the **iX5**.

14. The Polling System

Important Notice: The iX5 polling system is undergoing trialling/beta testing. Developers who wish to use these functions should fully evaluate all commands before use. Use of these commands may cause malfunction and the commands may change in future versions. See disclaimer.
An additional RS232 to RS485 convertor will be required for multiple reader systems.

The **iX5** incorporates a set of polling commands that will reasonably support up to 100 readers. The communications are full duplex however while a reader is servicing one command, subsequent commands will be ignored until the current command has completed. The commands employ a CRC checksum. In systems with multiple readers it is important that

the command data is thoroughly checked. For commissioning, a ‘FFFF’ checksum may be used, however for operational use a full checksum is recommended. Reader responses do not contain a checksum for speed. If a response is deemed to be corrupted then it is a simple matter to request another response because the reader address is known.
See ‘Cyclic Redundancy Check (CRC)’. See also Appendix4 - Worked examples of polled commands.

14.1 Polling Commands Table

CMD	Explanation	Form	Reader TX Response
CMD10	Login	[STX][Address][10][Parameter][Password][CRC][ETX]	[ACK]/[NAK]
CMD11	Send all cards	[STX][Address][11][CRC][ETX]	[STX][Card1][Cardn][CRLF][ETX]
CMD12	Assign Strikes	[STX][Address][12][Parameter][CRC][ETX]	[ACK/][NAK]
CMD13	Perform Strike	[STX][Address][13][Parameter][CRC][ETX]	[ACK][/NAK]
CMD14	Send Status	[STX][Address][14][CRC][ETX]	[STX][Settings][CRLF][ETX]
CMD15	New Address	[STX][Address][15][New Password][CRC][ETX]	[ACK]/[NAK]
CMD16	System	[STX][Address][16][Parameter][CRC][ETX]	[ACK]/[NAK]
CMD17	New Password	[STX][Address][17][New Password][CRC][ETX]	[ACK]/[NAK]
CMD18	Set Volts	[STX][Address][17][Parameter][CRC][ETX]	[ACK]/[NAK]
CMD19	Tune	[STX][Address][17][CRC][ETX]	[STX][Tune Setting][CRLF][ETX]

14.2 10-Series Polled Command General Form

The RS232 polled commands take the general form:-
[STX][Address][Command][Parameter][CRC][ETX]

Where:-

STX	=	Start of Transmission control code 02h
Address	=	Reader 4 character address
Command	=	Command number
Parameter1&2	=	The data passed from the host to the reader
CRC	=	Cyclic Redundancy Check
ETX	=	End of Transmission control character 03h
ACK	=	Command OK
NAK	=	Command not OK

15. 10-Series Polled Commands

CMD10 (Login) [STX][Address][10][Parameter][Password][CRC][ETX]

The Parameter: 01 = login
00 = logout.

Login is required before commands that change the system settings are permitted. Commands requiring login are CMD12, CMD15, CMD16 and CMD17.

Reader Reply ACK/NAK

CMD11 (Send All cards) [STX][Address][11][CRC][ETX]

Once the system settings have been set to poll-only operation the reader will not automatically send

card data and must be polled to send the latest cards. This command instructs the reader to send all the cards read since the last CMD11 command was performed. The reader can store up to 50cards and any cards in excess of this will be lost. Before using this command set up the system to polled-only by logging in with CMD10, and then selecting Poll-only using CMD15.

Reader Reply [STX][Card1] – [Cardn] – [Last Card][CR][LF][ETX]

CMD12 (Strike Period) [STX][Address][12][Parameter][CRC][ETX]

Where the Parameter	0	Strike1 = 3sec,	Strike2 = 3sec
	1	Strike1 = 3sec	S trike2 = 6sec
	2	Strike1 = 3sec,	Strike2 = 10sec
	3	Strike1 = 3sec,	Strike2 = 250mS
	4	Strike1 = 6sec,	Strike2 = 3sec
	5	Strike1 = 6sec,	Strike2 = 6sec
	6	Strike1 = 6sec,	Strike2 = 10sec
	7	Strike1 = 6sec,	Strike2 = 250mS
	8	Strike1 = 10sec,	Strike2 = 3sec
	9	Strike1 = 10sec,	Strike2 = 6sec
	A	Strike1 = 10sec,	Strike2 = 10sec
	B	Strike1 = 10sec,	Strike2 = 250mS
	C	Strike1 = 250mS,	Strike2 = 3sec
	D	Strike1 = 250mS,	Strike2 = 6sec
	E	Strike1 = 250mS,	Strike2 = 10sec
	F	Strike1 = 250mS,	Strike2 = 250mS

Note - Requires logon.

There are two main types of door strike. One type is normally energised and the other is normally not energized. The iX5 only supports normally off strikes. There are two strike drivers are both can be activated independently. The timing period for each can also be set independently.

Reader Reply ACK/NAK

CMD13 (Perform Strike/s) [STX][Address][13][Parameter][CRC][ETX]

The Parameter: 01 = Strike1 cycle
02 = Strike2 cycle
03 = Strike1 & 2 cycle

Reader Reply ACK/NAK

CMD14 (Send Status) [STX][Address][14][CRC][ETX]

The reader will send a status byte showing the door sensor status open/closed.

Reader Reply [STX][Status Byte][CR][LF][ETX]
Where 00 = Door Closed, 01 = Door Open : Leave bits 1 thru 7 blank for future.

CMD15 (New Address) [STX][Address][15][New Address][CRC][ETX]
The Parameter: New Address = 4 Hex Characters

Note - Requires logon.
The new address must consist of 4 hexadecimal characters. These must be chose from the normal range of hexadecimal characters, namely 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. Other characters are not allowed as they may contain ASCII control codes. There are 64,000 different addresses available.

Reader Reply [ACK][NAK]

CMD16 (System) [STX][Address][16][Parameter][CRC][ETX]
Parameter: Consists of 8 bits where
Bit0 Poll Mode on/off
Bit1-7 Not committed

To operate the reader in Poll mode this command should be sent with a parameter of 01. To return to normal mode the command should be sent with a parameter of 00. After this command it is advisable to log out.

Reader Reply [ACK][NAK]

CMD17 (New Password) [STX][Address][16][New Password][CRC][ETX]
New Password: Consists of 4 hexadecimal characters

Note - Requires logon.
The new password must consist of 4 hexadecimal characters. These must be chosen from the normal range of hexadecimal characters, namely 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. Other characters are not allowed as they may contain ASCII control codes. There are 64,000 different addresses available. After this command it is advisable to log out.

CMD18 (Set volts) [STX][Address][18][Parameter][CRC][ETX]
Parameter: Consists of 2 hexadecimal characters from 00-3F

Note - Requires logon.
This is function is normally performed at the factory and controls the voltage setting of the RF. The parameter must consist of 2 hexadecimal characters. These must be chosen from the normal range of hexadecimal characters, namely 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. Other characters are not allowed as they may contain ASCII control codes.

Reader Reply [ACK][NAK]

CMD19 (Send Status) [STX][Address][19][CRC][ETX]
The reader will perform a self-tuning function.

Reader Reply [STX][Tuning setting][CR][LF][ETX]

16. The Cyclic Redundancy Check (CRC)

A cyclic redundancy check helps detect corrupted data due to electrical interference. In multiple reader systems it is very important to be able to detect the presence of data errors. A corrupted command to change a password or an address can have serious consequences. The reader uses a standard (Modem) 16 bit CCITT CRC. For checking purposes several of CRC calculators can be found on line. To assist in testing, examples of implementations of this CRC in the popular PIC assembler code can be found in Appendix1, and for ARM thumb assembler code in appendix2 and ATmega series assembly code in appendix3. Worked out examples of Commands with appropriate CRCs can be found in appendix4.

The general form of the polled command is as,

[STX][Address][Command][Parameter2][Parameter2][CRC][ETX].

The CRC is calculated by taking each byte of the command starting at the address field thru to the end o the parameter field. Say the reader address is 1234 and command 12 is sent, with a 00 parameter, then the address field + the command field + the parameter field will be 12341200. This is divided into bytes as follows $12, $34, $12 and $00. The CRC methods described in the appendix select the $12 and run it through the CRC update, then the $34, the $12 and finally the $00. For these test values the CRC is $8ABB. The CRC implementations given in the appendix are continually cycling.

Users may use their own implementations CCITT CRC16 code, however it should be noted that the examples given are byte-based and the CRC is calculated much quicker than bit-based CRC checkers.

The command transmission will be received in ASCII from the RS232 network, however, these ASCII values are not used to calculate the CRC, the original hexadecimal values are. For example the byte $12 will be sent as an ASCII 31 followed by ASCII 32 but the iX5 uses the value $12 to calculate the CRC, without involvement in the ASCII transmission characters.

17. Cable Definitions

Wire color	Signal	Description
Red	PWR	+12V DC input
Black	GND	Ground
Blue	RS232	Serial RS232 Output (19,200:N,8,1)
Violet	RS232	Serial RS232 Input (19,200:N,8,1)
White	-	Do not connect
Green	-	Do not connect
Brown	Door Status	Sends the output of the door sensor. (Open/closed)
Orange	Strike 1	Remotely controlled door strike driver
Grey	Strike 2	Remotely controlled door strike driver.
Yellow	-	Do not connect
Screen	GND	Earth Screen

18. Emergency Reset

Passwords and addresses may get lost or mislaid. In these circumstances the user can perform an emergency reset back to the factory condition for password and address. To do this the user must isolate the reader from the other readers on line, switch off and on, and then use a terminal to type in the word ‘RESET’ within 4 seconds of switch on. The settings for the terminal must be 19200: N, 8, 1 (19,200 baud, no parity, 8 data bits and 1 stop bit). The reader will reset and return to the original factory values. The factory reset values are:- Password = 0000 and Address = 0000. The reset will not change the other system settings, such as the Strike assignment and mode of operation poll/normal. See Appendix4 for worked example of command. The examples shown in the appendix use a popular free terminal program.

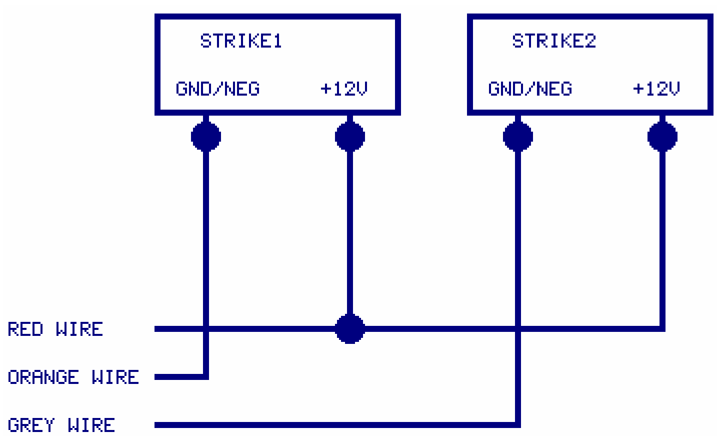
Note that a CRC checksum of $FFFF will be accepted for testing, however for system integrity a calculated CRC checksum should be used if there are multiple readers.

19. The Door Strike Drivers.

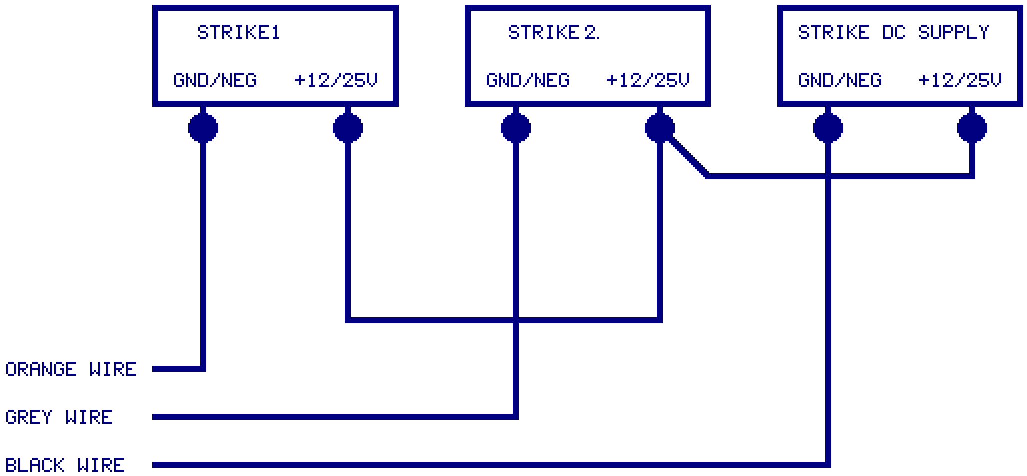
The Strike drivers are independent and may be operated singly and also set up for different strike periods. The strike power should be preferably taken from the 12volt DC reader supply. A maximum voltage of 25v is allowed for the strike and the maximum current should not exceed 0.5amp each or 1A in total, due to cable restrictions. The nominal resistance of each strike should be greater than 25 ohms.

If the strike is set to normally-on then the maximum permissible current is 250mA for each strike, and the strike resistance should be greater than 50 ohms. The strike drivers are rugged intelligent FETs with inbuilt protection. The driver circuit has an additional reverse voltage diode for inductive spikes. If an external DC power source is used for the strike then care must be taken to avoid reverse polarity, the FET driver is protected but reverse current through the safety diode can cause damage to the copper track, the cables and the diode itself.

The strike is controlled by polled commands but it should be noted that these commands may still be used in normal mode. The appropriate polled command [$02][0000][13][01][FFFF][$03] will operate strike1, [$02][0000][13][02][FFFF][$03] will operate strike2, while [$02][0000][13][03][FFFF][$03] will operate strike1&2. Note that for single reader applications the CRC test value of FFFF can safely be used. The period and the type of strike, may also be set using polled commands. See polled commands and also appendix4.



Above - Wiring Diagram for using Reader 12v Supply



Above – Wiring Diagram Using Separate DC power Supply

20. The Door Sensor

It is many applications it is important to know if the door has been closed properly. The iX5 door sensing circuitry is connected to the brown wire. When the reader is polled with command 14, the reader will send [$02][00][0A][0D][$03] if the voltage on the brown wire is under 2volt and [$02][01][0A][0D][$03] if the voltage is greater than 2volt. A contact closure taken from the brown wire to 12volt will be suitable.

21. Connections to a computer RS232 Port using a DB9 Socket.

Pin1 NC
Pin2 (Computer RS232 out) (Reader RS232 in) Purple Wire
Pin3 (Computer RS232 in) (Reader RS232 out) Blue Wire
Pin4 NC
Pin5 (Ground, 0volt) Black Wire
Pin6-9 NC

22. Useful Information

For general testing we recommend the Bray terminal free from the net. It is the best software we have seen. It is available at http://braypp.googlepages.com/terminal truly excellent. The examples described will be detailed using this program, although others may be used including hyper terminal.

For all technical help contact ID-Innovations at help@id-innovations.com

For users wishing to send commands manually, STX ($02) can be sent using CNTR/A and ETX ($03) can be sent using CNTR/C.

23. Contact Information

Sales: wendy@id-innovations.com
Technical support help@id-innovations.com

24. Disclaimer

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This product contains polled command software that is still undergoing testing and has been described as such in the data sheet. The user should understand that he uses these commands at his own risk. In particular the user should understand that the commands may contain errors, may cause malfunction and that the commands themselves may change in future versions.

Appendix1 - CRC calculation in PIC assembly language.

```
;--------------------------------------------------------------------
; Beginning of test program
;--------------------------------------------------------------------
PERF_CRC
        CALL    CRC_Init
        movlw   12
        CALL            CRC_Update
        movlw   34
        call    CRC_Update
        movlw   12
        call    CRC_Update
        movlw   00
        call    CRC_Update      ;CRC   8ABB
        jmp     PERF_CRC                ;Loop indefinitely for test.

CRC_Init
         movlw          0x00            ; Preload the CRC Registers with 0x00
        movwf   CRC16_HIGH
        movwf   CRC16_LOW
        retlw   0
```

```
CRC_Update
          xorwf   CRC16_HIGH,w
          movwf   INDEX
          andlw   0xf0
          swapf   INDEX,F
          xorwf   INDEX,F

  ; High byte
          movf     INDEX,W
          andlw   0xf0
          xorwf   CRC16_LOW,W
          movwf   CRC16_HIGH
          rlf     INDEX,W
          rlf     INDEX,W
          xorwf   CRC16_HIGH,F
          andlw   0xe0
          xorwf   CRC16_HIGH,F
          swapf   INDEX,F
          xorwf   INDEX,W
          movwf   CRC16_LOW
          retlw   0
```

Appendix2- CRC calculation in ARM Thumb assembly language.

```
;--------------------------------------------------------------------
; Beginning of test program
;--------------------------------------------------------------------
Perf_crc
          bl      crc16_INIT
          Ldr     r1,=0x12
          bl      CRC_update
          Ldr     r1,=0x34
          bl      CRC_update
          Ldr     r1,=0x12
          bl      CRC_update
          Ldr     r1,=0x00
          bl      CRC_update                 ;CRC = 8ABB
          b       Perf_crc                   ;Loop indefinitely for test.
crc16_INIT
          push    {lr,r1}
          ldr     r1,=0x00                    ; Preload the CRC Registers with 0x00
          strb    r1,[r11,#CRC16_hi_b]
          strb    r1,[r11,#CRC16_lo_b]
          pop     {r1,pc}

CRC_update
          push    {lr,r0,r2,r3,r4}
          ldrb     r3,[r11,#CRC16_hi_b]
          ldrb     r4,[r11,#CRC16_lo_b]
          eor     r1,r3,r1
          mov     r2,r1
```

```
        and     r1,#0xf0
        lsl     r2,#4
        ubfx    r0,r2,#8,#4
        add     r2,r0
        and     r2,#0xff
        eor     r2,r1
        and     r1,r2,#0xf0
        eor     r3,r4,r1
        lsl     r1,r2,#1
        tst     r1,#0x100
        orrne   r1,#0x01
        and     r1,#0xff
        eor     r3,r1
        and     r1,#0xe0
        eor     r3,r1
        lsl     r2,#4
        ubfx    r0,r2,#8,#4
        add     r2,r0
        and      r2,#0xff
        eor       r1,r2,r1
        mov     r4,r1
        strb    r3,[r11,#CRC16_hi_b]
        strb    r4,[r11,#CRC16_lo_b]
        pop     {r4,r3,r2,r0,pc}
```

Appendix3- CRC calculation in Atmel ATmega assembly language.

```
;---------------------------------------------------------------------
; Beginning of test program
;---------------------------------------------------------------------
Test:   call    inits
        ldi     r16,#0x12
        CALL            CRC_Update3    ;
        ldi     r16,#0x34
        CALL            CRC_Update3    ;
        ldi     r16,#0x12
        CALL            CRC_Update3    ;
        ldi     r16,#0x00
        CALL            CRC_Update3    ;          ;CRC = 8ABB
        Jmp     Test                           ;Loop indefinitely for test

Inits:  ldi     r16,0x00                       ; Preload the CRC Registers with 0x00
        sts     CRC16_HIGH, r16
        sts     CRC16_LOW, r16
        ret

CRC_Update3:
        lds     r17, CRC16_HIGH
        eor     r16, r17
```

```
        sts     INDEX, r16
        andi    r16, 0xf0
        lds     r17,index
          swap          r17
          eor   r16, r17
        sts     index, r16
; High byte
        andi    r16, 0xf0
        lds     r17, CRC16_LOW
        eor     r16, r17
        sts     CRC16_HIGH, r16
        lds     r17, index
        rol     r17
          lds   r17, index
        rol     r17
        lds     r16, CRC16_HIGH
        eor     r16, r17
        sts     crc16_high, r16
        andi    r17, 0xe0
        lds     r16, crc16_high
        eor     r16, r17
        sts     crc16_high, r16
        lds     r16, index
        swap    r16
        sts     index, r16
        eor     r17, r16
        sts     crc16_low, r17
        ret
```

Appendix4 - Worked examples of polled commands.

All polled commands assume an initial reader address and password of 0000

1) Login - Explained in detail
2) Logout
3) Change mode to poll
4) Change mode to non poll
5) Assign strike mode
6) Perform Strike
7) Read Door Contacts
8) Change Reader Address
9) Change Reader Password
10) Emergence Reset Password and Address

1) Command 10, Logon/off - Explained in detail

System values may only be changed if the user has Logged in with the reader password. The reader password as supplied is $0000 and the reader address is $0000

General Form ; [STX][Address][10][Parameter][Password][CRC][ETX]

Logon on ; [$02] [$0000] [$10] [$01] [0000] [$2C97] [$03]

As Appears on Bray Macro ; $020000100100002C97$03 or $02000010010000FFFF$03

Log off ; [$02] [$0000] [$10] [$00] [0000] [$1BA7] [$03]
As Appears on Bray Macro ; $020000100000001BA7$03 or$02000010000000FFFF$03

Step1 Run the Bray terminal. See ‘Useful Information – Bray terminal’
Step2 Set up terminal to 19200 baud, no parity, 8 data bits, 1 stop bit.
Step3 Click ‘Connect’
Step4 Set keyboard to Upper Case
Step5 Click ‘Set Macros’. The Macro table 1 thru 24 will appear.
Step6 In M1 type $020000100100002C97$03

OR

In M1 type $02000010010000**FFFF**$03 - Using test CRC = $FFFF

(Take Note that the control keys have been preceded by a ‘$’, all other values are normal hex values)
Step7 Click ‘M1’ once and this will send the command.

2) Command 11, Send all Cards
As Appears on Bray Macro $020000110210$03 or $02000011FFFF$03

3) Command 12, Strike Period
Example - select both 6 second
As Appears on Bray Macro $02000012056511$03 or $0200001205FFFF$03

4) Command 13 Perform strike
Example – Cycle both Strike1 &2
As appears n Bray Macro $02000013036643$03 or $0200001303FFFF$03R

5) Command 14 Read Door Status
As appears in Bray Macro $0200001452B5$03 or $02000014FFFF$03

6) Command 15 Change Reader Address			
As appears in Bray Macro	$020000151234BB55$03	or	$020000151234FFFF$03
7) Command 16 Set System Response			
Example – Set to Normal			
As appears in Bray Macro	$0200001600A9D5$03	or	$0200001600FFFF$03
8) Command 17 Change Password			
Example 1, change from 0000 to 3333	$0200001733339005$03	or	$020000173333 FFFF$03
Example 2, Change from 3333 to 0000			
As appears in Bray Macro	$020000170000C6F3$03	or	$020000170000FFFF$03
10) Command 18 Set Power			
Example 1, Set power to 1F (HEX)	$020000181F6904$03	or	$020000181FFFFF$03
11) Command 19 Tune			
Example 1, Tune Reader	$020000198318$03	or	$02000019FFFF$03

Appendix5 - Error Messages

Err1 External Beeper Connection Problem Detected

If the Reader Model has an External Beeper connection the beeper has been disabled due to a possible external short. The reader will continue without beeping.

Err2 Current Overload Detected

The reader has detected a high current and will close down and restart.

Err3 RF High Voltage Detected

The reader has detected an RF high voltage. This may be due to the proximity of metal works or another nearby reader. The reader will close down and start again.

Err4 RF High Current Detected

The RF circuits are drawing high current. The reader will incrementally reduce RF power over a period of time until RF current is acceptable.

Err5 Memory Problem Detected

The system has detected a CRC error on its firmware. This can be caused by a reader failure, X rays, neutrino bombardment, lightning, laser cannon or tampering. If the message is repeated contact the vendor.

Err6 Amplifier High Volt Condition Detected

One of the internal amplifiers has a fault condition

Err7 Amplifier Low Volt Condition Detected

One of the internal amplifiers has a fault condition.

Err8 Tuning at High Limit Warning

The reader is probably too near substantial metal fixtures.

Err9 Tuning at Low Limit Warning

The reader is probably too near substantial metal fixtures.

Appendix6 - Information Messages

Poll Address and Poll Password reset to 0000 - (Restarting reader now).

The message received after a user 'RESET' command is used. The address and password have been reset to '0000'