Understanding Card Data Formats

Wiegand™ Format

The term Wiegand is applied to several characteristics related to access control readers and cards. Unfortunately, the word is used carelessly and can lead to unnecessary confusion. Here are the basics.
Wiegand is:

1. A specific reader-to-card interface
2. A specific binary reader-to-controller interface
3. An electronic signal carrying data
4. The standard 26-bit binary card data format
5. An electromagnetic effect
6. A card technology

For the purposes of this white paper, we will address items 2 and 4.
(NOTE: There are additional card/reader attributes that are also described by the term, Wiegand.)

When HID customers say, "Wiegand format", they typically refer to the general concept of security card data encoding. But be aware that the term, Wiegand format, is also often understood to mean the standard 26-bit format, which is a very specific arrangement of binary card data. Some basic facts:

- A format describes what a number means, or how a number is used. The format is not the number itself,
- The number of bits does not indicate the format except for standard 26-bit. For example, there are over 100 different 34-bit formats alone.
- Within a given bit length (34-bit, 37-bit, etc.), the size and location of each data element may change. For example:
  - One 34-bit format may have an 8-bit Facility Code starting with bit #2.
  - Another 34-bit Facility Code may be 12 bits starting with bit # 21.
- The capability of the access control panel will dictate what formats will and will not work.

If I see a string of numbers, 19495981699 it may mean nothing. If you describe it as a phone number in the United States, then it is immediately understood that 949 is the area code, etc. Knowledge of the format allows you to decode the data. It always appears in the format, (xxx) yyy-zzzz, because telephone company switching equipment specifies it exist in this format.

The telephone company has maintained this format for many years and migrated to it slowly over the years adding numbers in groups. Security equipment has similar format demands however the security industry does not want the format known and they often change the formats to keep the changes confidential.

All specific card formats are identical in both 125 kHz Prox and 13.56 MHz iCLASS® cards. This ensures that any controller capable of understanding data from 125 kHz cards and readers will also seamlessly work with 13.56 MHz cards and readers.

The Standard 26-Bit Format

The format in which a card is programmed is determined by the data pattern that will be compatible with the access control panel. All HID credentials (card, fobs, tags, etc.) can be programmed with the standard 26-bit card data format.

The Standard 26-bit Format is an Open Format.
An Open Format means that anyone can buy HID cards in a specific format and that specific format description is publicly available. The 26-bit format is a widely used industry standard and is available to all HID customers. Almost all access control systems accept the standard 26-bit format. 26-bit originated with true Wiegand swipe card technology.

The HID ordering code number for the Standard 26-bit format is H10301.

H10301 has 255 possible facility codes from one to 255. There can be up to 65,535 card ID numbers, from one to 65,535, per facility code. The total number of cards that can use the entire range without duplication is 16,711,425. There are no restrictions on the use of this format. It is not documented by HID and HID does not restrict duplication of card numbers.

HID produces and manages over 1,000 other card data formats, but all of them share the same fundamental concepts as the 26-bit format. Other card manufacturers also have unique, proprietary formats.

H10301 describes binary encoded data. The format is represented in the next figure:

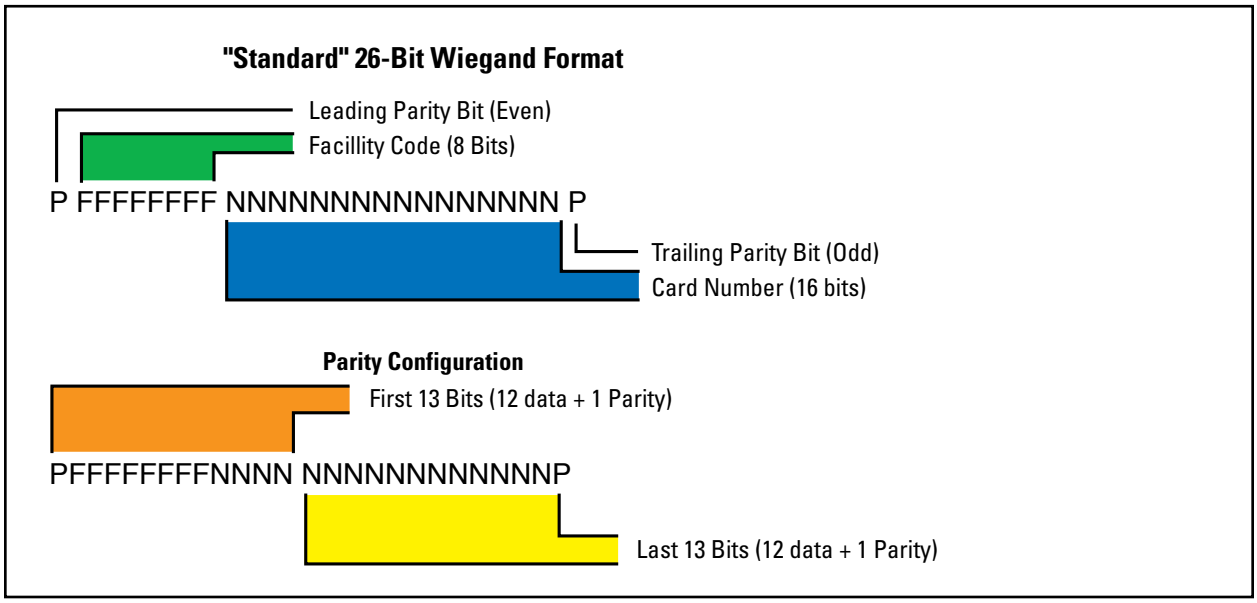

Figure 1: 26-Bit Wiegand Public Format

- The maximum Facility Code is 255 because if all eight Facility Code bits are set to ones, they equal 255 decimal.
- The maximum Card Number is 65,535 because when all sixteen Card Number field bits are ones, it equals decimal 65,535.

A NOTE ON PARITY: A parity bit is used as a very simple quality check for the accuracy of the transmitted binary data. The designer of the format program will decide if each parity bit should be even or odd. A selected group of data bits will be united with one parity bit, and the total number of bits should result in either an even or odd number.

In the example above, the leading parity bit (even) is linked to the first 12 data bits. If the 12 data bits result in an odd number, the parity bit is set to one to make the 13-bit total come out even. The final 13 bits are similarly set to an odd total.

Other Hypothetical Formats

To further clarify how formats may be organized, we present two additional hypothetical examples.

NOTE: Since actual formats do require a varying degree of security, we will only present hypothetical examples with the exception of standard 26-bit.

In the standard 26-bit format, H10301, or the programmable field is specified as the Facility Code. The incrementing field is called the Card Number. These data groupings can have many different names depending upon which format is under discussion. The same name usually means something different from format to format. Therefore, another hypothetical format could look like this:

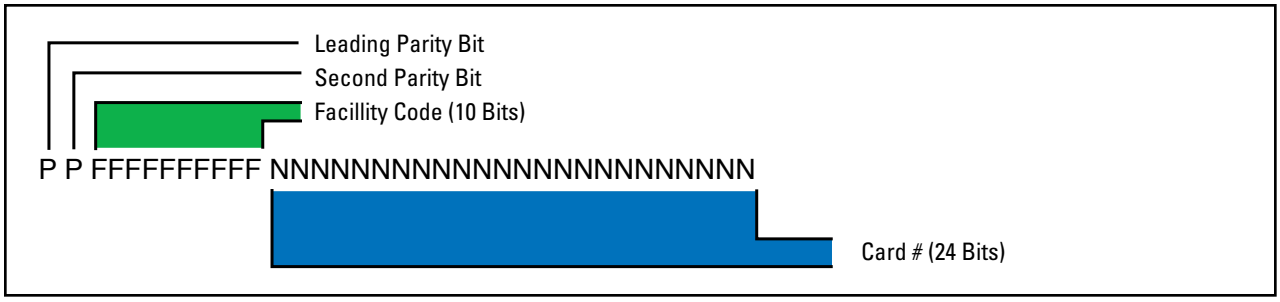

Figure 2: Hypothetical 36-Bit Card Data Format

The Leading Parity bit could relate to one subset of the data string and the Second Parity bit relate to an entirely different subset. This format also has fields named Facility Code and Card Number, but if you compare it to H10301, its format is very different, and would probably not work on a customer's system that was setup for H10301.

The person who creates the format's unique field names has the ability to assign the names as well. Review the following hypothetical format:

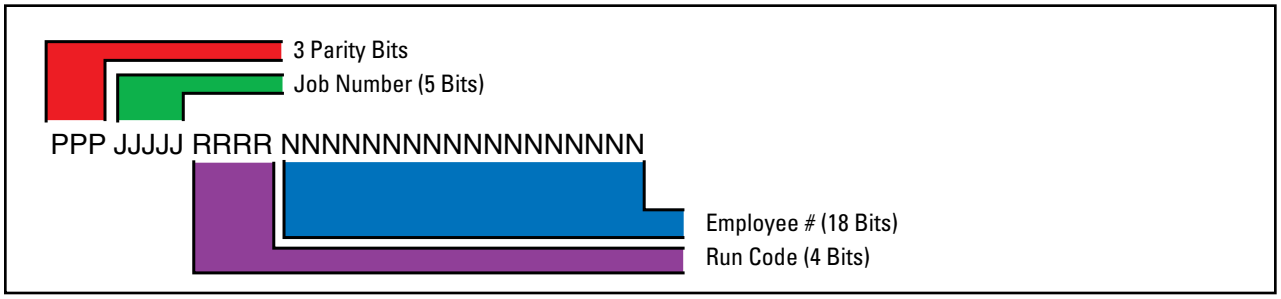

Figure 3: Hypothetical 30-bit Card Data Format

This format has three parity bits, a five-bit programmable field called Job Number, another four-bit programmable field called Run Code, and an 18-bit incrementing field called Employee Number.

When taking information from a customer about their format, it is important to obtain the exact values they want in the programmable fields. The customer, not HID, supplies this information.

Please note that customers often confuse the terms, Facility Code and Site Code. Some formats have a field called Facility Code and others have a Site Code, while others may have neither – or both. You must be certain to utilize the correct terms when ordering your cards.

To avoid duplicating cards that are already in use on a site, customers must know the existing card numbers.

System installers will also need to know the format name, and specific field information in order to setup their security panels and enroll cards. In fact, it is almost impossible to batch enroll cards without these specifics. HID always includes a Cross Reference List with every card order that has the format, and all specific card data listed. HID sales orders and card box labels also include this same information.

Corporate 1000

HID offers a unique card data format program named Corporate 1000, where the end user owns the unique format and HID guarantees that the customer's format will not be duplicated. Furthermore, the customer must provide written authorization to HID for an integrator or distributor, etc. to be able to purchase the specified Corporate 1000 cards from HID. This gives the customer absolute control over the manufacture, distribution and delivery of their specific cards. Additional Corporate 1000 facts:

- The customer's access control panels must be capable of decoding the Corporate 1000 format.
- All Corporate 1000 formats are 35 bits long but the data will be arranged in different increments along that 35-bit string. A card number, for example, may be broken into three or more parts and randomly spaced along the string. This ensures uniqueness in every Corporate 1000 format.
- HID currently manages several hundred unique Corporate 1000 formats and many more are still readily available.
- As with all other formats, Corporate 1000 formats are identical in 125 kHz Prox and 13.56 MHz iCLASS contactless smart card technology.

The Wiegand Reader-to-Controller Interface

An interface defines how two devices communicate with one another. Various HID readers can communicate with access control panels using a variety of well-established, industry-standard interfaces including:

- Wiegand
- Serial (RS232, RS422, RS485)
- Clock-and-Data (Magnetic Stripe Track/2) – Also known as ABA format.

We will concentrate on the Wiegand interface because it is the most prominent industry interface for card access control.

The Wiegand interface consists of three conductors (wires) called Data Zero (usually green), Data One (usually white), and Data Return (usually black). When installers obtain an HID reader, they expect to see these three names on the connection points (terminals) for both the reader and the access control panel. All current standard HID reader types are available with a Wiegand interface. The three wires carry Wiegand data, also called the Wiegand signal.

Since the card data is binary, the reader simply receives the radio frequency (RF) data from the card, translates it from RF to Wiegand protocol and sends the complete binary string to the controller. Zeros travel on the green wire, ones on the white wire and the controller combines the two strings of characters into the original set of binary data.

NOTE: The reader performs no processing or quality checking of the data. It simply receives the (RF) data from the card and converts it to Wiegand protocol for immediate transmission to the controller.

Panel Format Settings

Access control panels are built to reject card data that does not conform to a specific pre-defined format. Almost all panels can use the 26-bit standard format (possibly in addition to the manufacturer's own proprietary formats). Simple panels might use only one or two formats, but more sophisticated panels are software configurable and accept virtually all of the different formats. Some can even create customized formats. Once a format is determined, the panel is then configured. Proximity cards must be ordered for use with that configured format and the card must be programmed to conform to the panel's format in order to function.

This one-way flow of setup information from panel to card is intentional. It makes it difficult for an unauthorized person who finds a proximity card to know where and how to use it. Even a person with the technical knowledge and equipment cannot positively identify the card format. The reason is due to the format information residing in the panel and not on the card. A format is not a number — it is a way of looking at a number. The card data merely conforms to the panel format.

There are several essential pieces of information for placing HID card orders.

- Format Name (Example: H10301.cdf) - HID programs cards for our customers using hundreds of existing formats. There is no default format. The customer must always specify to HID which format they want.
- Programmable field information - Looking again at H10301.cdf, it has a Leading one-bit parity field, followed by an eight-bit programmable field, a 16-bit incrementing field and a Trailing Parity bit.

Math Translations – Decimal, Binary and Hexadecimal

While our everyday math is based on the decimal system, computers always use binary math. In binary, each column can only contain a one (1) or zero (0). Binary data is often combined together into convenient four-bit hexadecimal, or hex units called Nybbles. Hex values are displayed as 0 – F.

1	00000001	1
2	00000010	2
3	00000011	3
4	00000100	4
5	00000101	5
6	00000110	6
7	00000111	7
8	00001000	8
9	00001001	9
10	00001010	A
11	00001011	B
12	00001100	C
13	00001101	D
14	00001110	E
15	00001111	F
16	00010000	10
32	00100000	20
64	01000000	40
100	01100100	64

With hexadecimal, 24 bits can be represented with only six characters.
(1111) (1111) (1111) (1111) (1111) (1111) Groups of four bits called Nybbles.
F F F F F F

- A Facility Code of 255 looks like FF in hex (15 x 16) + 15 = 255
- An identification number of 65535 looks like FFFF in hex
  (15 x 4096) + (15 x 256) + (15 x 16) + 15 = 65535

Many panels use hexadecimal math because it is compact, and directly represents binary. HID ProxPro® and MaxiProx® readers can be configured to output data to the panel in hex via RS232 or RS422.