Wiegand Translator Guide

Encompass® 3 and Encompass 4

16-0088-001 Rev C 1/2022

This document describes the Wiegand data translation feature for the Encompass 3 and Encompass 4 readers. This feature allows for translation of various tag protocols into one of five different Wiegand formats, ranging from 26 to 37 bit.

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Wiegand Formats

The E4 can be configured to translate reads of various tags into one of the Wiegand formats described in Tables 1 through 5.

Table 1 – 26-bit Wiegand Fields

Bit	No. of Bits	Maximum Value	Description
1	1	1	Even parity over bits 2 through 13
2-9	8	255	Facility Code or Site ID
10-25	16	65,535	Card ID or Serial Number
26	1	1	Odd parity over bits 14-25

Table 2 – 32-bit LSU Fields

Bit	No. of Bits	Maximum Value	Description
1	1	1	Even parity over bits 2 through 16
2-17	16	65,535	Card ID (Serial Number)
18-21	4	15	Issue Number (defaults to all zeros)
22-31	10	1,023	Facility Code (Site ID)
32	1	1	Odd parity over bits 17 through 31

Table 3 – 34-bit Cardkey 3410 Fields

Bit	No. of Bits	Maximum Value	Description
1	1	1	Fixed to a value of 1
2-17	16	65,535	Card ID (Serial Number) – ***Bits Reversed****
18-20	3	7	Issue Number (defaults to all zeros)
21-33	13	8,191	Facility Code (Site ID) – ***Bits Reversed****
34	1	1	Fixed to a value of 0

* Note: For 34-bit Cardkey, bits are reversed for the Card ID and Facility Code fields

Table 4 – 35-bit HID Fields

Bit	No. of Bits	Maximum Value	Description
1	1	1	Odd parity over bits 2 through 35 (calculate this parity last)
2	1	1	Even parity over bits* (calculate this parity first)
3-14	12	4,095	Facility Code (Site ID)

Table 4 – 35-bit HID Fields

Bit	No. of Bits	Maximum Value	Description
15-34	20	1,048,575	Card ID (Serial Number)
35	1	1	Odd parity over bits** (calculate this parity after Even parity above)

* Bit 2 Even parity over bits: 3,4,6,7,9,10,12,13,15,16,18,19,21,22,24,25,27,28,30,31,33,34
** Bit 35 Odd parity over bits: 2,3,5,6,8,9,11,12,14,15,17,18,20,21,23,24,26,27,29,30,32,33

Table 5 – 37-bit McGann Fields

Bit	No. of Bits	Maximum Value	Description
1	1	1	Even parity over bits 2 through 18
2-15	14	16,383	Facility Code (Site ID)
16-36	21	2,097,151	Card ID (Serial Number)
37	1	1	Odd parity over bits 19 through 36

Table 6 – Wiegand Quick Reference Table

Bit Structure	Number of Bits in Facility Code	Number of Bits in ID
SIA 26-bit Standard	8	16
LSU 32-bit	10	16
Cardkey 3410 34-bit	13	16
HID 35-bit	12	20
McGann 37-bit	14	21

Table 7 – Commands

Command:	Reader Response:	Description:
#863hhhh	#Done	Set fixed facility code value (4 hex chars)
#870	#Done	Disable Wiegand conversion (factory default)
#871	#Done	Enable 26-bit format
#872	#Done	Enable 32-bit LSU format
#873	#Done	Enable 34-bit Cardkey 3410 format
#874	#Done	Enable 35-bit HID format
#875	#Done	Enable 37-bit McGann format
#878	#Done	Disable fixed facility code (factory default)
#879	#Done	Enable fixed facility code

These configuration settings are stored in NVM until a reset is issued.

ATA/eATA ASCII Data Format

The ATA/eATA ASCII data format consists of four fields (Table 8). Only the first two fields are used by the translator. This ASCII format is standard for all ATA toll applications.

Table 8 – ATA/eATA Toll Data Fields

Field	Description	Format	No. of 6-bit ASCII Characters
1	Toll Identifier (Typically alpha with decimal as the last character – i.e. “KTA.”, “OTA.”, etc.)	Alphanumeric	4
2	Serial Number	Numeric (0 – 9)	8
3	CRC (not used by translator)	Hexadecimal	2
4	Security Characters (not used by translator)	6-bit	6

When the translation feature is enabled, the reader will generate the specified Wiegand output data based on the first two ATA data fields.

The pre-defined default translations for the ATA Toll Identifiers are illustrated by Table 9.

Table 9 – Default ATA/eATA Toll Identifier Translations

Toll Identifiers	Translated Wiegand Facility Code	Authority
HCTR	1	HCTRA Harris County Toll Road Authority – “EZ TAG”
DNT	2	North Texas Tollway Authority (NTTA) – “TollTag”
TEX	2	TxDOT – “TxTag”
OTA	3	Oklahoma Turnpike Authority – “PikePass”
KTA	4	Kansas Turnpike Authority – “K-TAG”
FDOT	5	FTE – Florida Turnpike – “SunPass, SunTrax”
LEE	5	Lee County – “LeeWay”
OOCE	5	Central Florida Expressway Authority – “E-Pass”
NCTA	6	NCDOT - North Carolina Turnpike Authority – “NC QuickPass”
All Others	15	

If the reader is configured to output a fixed Wiegand Facility Code (#863hhhh), that setting will override the Wiegand Facility Code settings defined in Table 9.

The numeric Serial Number field will be directly translated to the Wiegand Card ID number output. If the toll Serial Number exceeds the maximum Card ID range for the Wiegand output selected, the reader will truncate the Serial Number.

The serial number is translated using a simple algorithm to minimize duplicates for a given bit-structure and ensure the ID will always be allowed in a given bit structure. The modulus (modulo) operator is used to

calculate the Wiegand ID. The modulus (normally represented by %) is the result of dividing the initial value and using the remainder as the answer.

Example:

8 mod 3 = 2

In this example, 3 cannot go into 8 a whole number amount of times, so the result is 2. There are a wide variety of modulus calculators available for free online. However, a simple modulus calculator can be created in Microsoft Excel. Type the following in an Excel cell:

=MOD(X, Y)

Where X is the ID and Y is the divisor, i.e. MOD(8, 3) = 2.

To get the Wiegand ID (ID_{final}) that will be sent via the Wiegand interface, take the first 8 numeric values after the 4-digit Authority code ($ID_{initial}$). The divisor is calculated using the maximum value for the ID of a given bit structure. To get this number, take the number of bits for an ID, allocated in a given bit structure using the table below and raise 2 to the power of the number of bits in an ID.

Bit Structure	Number of Bits in ID
SIA 26-bit Standard	16
LSU 32-bit	16
Cardkey 3410 34-bit	16
HID 35-bit	20
McGann 37-bit	21

Using 26-bit as an example:

$ID_{final} = ID_{initial} \bmod 2^{16}$

If the initial ID is 85632187, the equation would be written as ID_{final} = 85632187 mod 65536 = 42171.

These configuration settings are stored in NVM until a reset is issued.

SeGo/eGo Tag ID Data Format

The SeGo/eGo Tag ID consists of 8 hexadecimal bytes subdivided into four data fields as defined in Table 10. The translator uses two of these fields, the Ownership Code (bytes 2 & 3), and the Tag ID Serial Number (bytes 4 – 6).

Table 10 – 8-Byte SeGo/eGo Tag ID Fields

Field	Bytes	Range of Values	Description
1	0, 1	0000 to FFFF	ISO Code E022 (for tags with eGo enabled), tag configuration and partial CRC for tags without eGo enabled. (This field is not used by the translator)
2	2, 3	0000 to FFFE	Ownership Code
3	4 – 6	000000 – FFFFFF	Serial Number
4	7	00 to FF	CRC (Not used by the translator)

The reader uses these two fields to generate the Wiegand Facility Code and Card ID output. The SeGo Tag ID-to-Wiegand translations are defined as follows:

Wiegand Facility Code = Decimal value of the Ownership Code, bytes 2 & 3 (16 bits).

Wiegand Card ID = Decimal value of the SeGo Serial Number, bytes 4 – 6 (24 bits).

If the reader is configured to output a fixed Wiegand Facility Code (#863hhhh), that setting will override the Wiegand Facility Code being calculated from the SeGo Ownership Code.

Consider the following example using the SeGo/eGo ID: E0224B54068660FB.

In Figure 1, starting from the LSB (least significant bit) and counting left, the number of bits reported correspond to the number of bits for each field outlined in “Table 6 – Wiegand Quick Reference Table” on page 5.

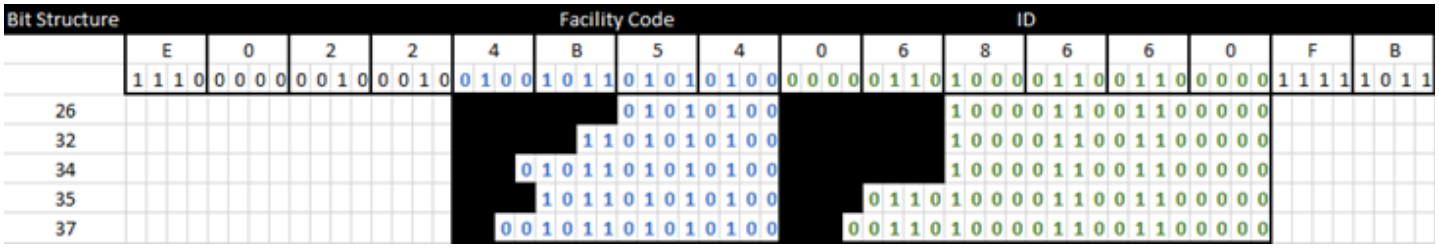

Figure 1 SeGo/eGo Bit Fields

The binary values can then be converted to decimal to get the following values shown in Table 11:

Table 11 – Decimal Values

Bit Structure:	Facility Code:	ID:
26	84	34400
32	852	34400
34	2900	34400
35	2900	427616
37	2900	427616

IAG Toll Data Format

NOTE: This feature is available only on the Encompass 4.

The read-only portion of the IAG Tag response consists of 12 hexadecimal bytes subdivided into 15 data fields as defined in Table 12.

Table 12 – IAG Read Response Data Fields

IAG Read Response									Data Payload
Fields	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	
	Read Only Partition								
Data	Header (3 Bits)			Tag Type (3 Bits)			App ID * (3 Bits)		XXH
Data	App ID	Group ID (7 Bits)							XXH
Data	Agency ID (7 Bits)							SN (MSB)	XXH
Data	Serial Number (24 Bits)								XXH
Data	Serial Number								XXH
Data	Serial Number (LSB)							...	XXH

The translator uses two of these fields, the Agency ID and Serial Number, as illustrated in Table 13.

Table 13 – IAG Read-Only Fields

Field	Number of Bits	Range of Values	Description
1	7	00 to 7F	Agency ID
2	24	000000 – FFFFFF	Serial Number

The reader uses the two IAG fields shown in Table 13 to generate the Wiegand Facility Code and Card ID output respectively. Definitions for the IAG-to-Wiegand translations are defined as follows:

Wiegand Facility Code = Decimal value of the Agency ID.

Wiegand Card ID = Decimal value of the IAG Serial Number.

If the reader is configured to output a fixed Wiegand Facility Code (#863hhhh), that setting will override the Facility Code being calculated from the IAG Agency ID.

If the IAG Serial Number exceeds the maximum Card ID range for the Wiegand output selected, the reader will truncate the Serial Number.

These configuration settings are stored in NVM until a reset is issued.

Consider the following example using an IAG transponder:

E0C108EC59AACBC4000000000000000000000544994AA0C5C011110CC04EC6984

IAG only reserves 7 bits for the Agency ID (highlighted in blue in Figure 2). As a result, additional zeros (highlighted in red in Figure 2) are appended to the MSB (most significant bits) to output the correct

number of bits for a given bit-structure (refer to "Table 6 – Wiegand Quick Reference Table" on page 5).

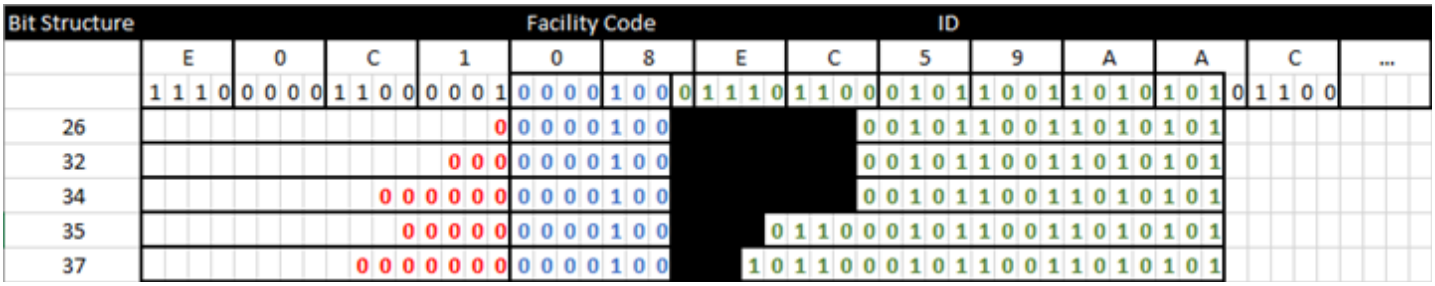

Figure 2 IAG Bit Fields

Title 21 Data Format

NOTE: This feature is available on the Encompass 3

The Title 21 Transponder ID Number is subdivided into three data fields, representing the Tag Type, Facility Code, and Internal Tag ID. These fields are defined in Table 14.

Table 14 – 32-bit Title 21 Fields

Bit	No. of Bits	Maximum Value	Description
1	4	0 – 15	Tag Type
5	18	0 – 262,143	T21 Facility Code
23	10	0 – 1,023	Internal Tag ID (Serial Number)

When Wiegand translation is enabled, the reader uses the least significant bits (LSB) of the 32-bit Title 21 ID for the Wiegand Card ID. The next significant bits are used to generate the Wiegand Facility Code. For example:

Using the T21 transponder: 0B61E5B0. Refer to Table 1 "Graphic 3 – T21 Bit Fields"

26-bit Facility Code = 8 bits (bits 17 – 24)

26-bit ID = 16 bits (bits 1 – 16)

37-bit Facility Code = 14 bits (bits 22 – 32)*

37-bit ID = 21 bits (bits 1 – 21)

*There are not enough unique bits to accommodate both the ID and facility code for 37-bit McGann. Consequently, the reader generates an additional 3 zeros and appends them to the next most significant bits of the facility code.

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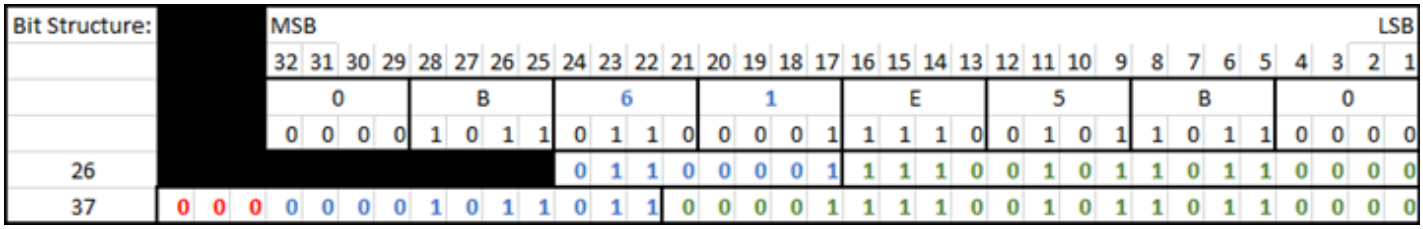

Figure 3 T21 Bit Fields

Translations for the five Wiegand formats are provided in Table 15.

Table 15 – Title 21 to Wiegand Field Data Translation bit Definitions

Wiegand Format	Wiegand Bit #	No. of Bits	Title 21 Bits	Description
26 Bit	2 – 9	8	17 – 24	Facility Code (Site ID)
	10 – 25	16	1 – 16	Card ID (Serial Number)
32 Bit	2 – 17	16	1 – 16	Card ID (Serial Number)
	22 – 31	10	17 - 26	Facility Code (Site ID)
34-Bit	2 – 17	16	1 – 16	Card ID (Serial Number) – Field Reversed
	21 – 33	13	17 – 29	Facility Code (Site ID) – Field Reversed
35-Bit	3 – 14	12	21 - 32	Facility Code (Site ID)
	15 – 34	20	1 – 20	Card ID (Serial Number)
37-Bit	2 – 15	14	22 - 32	Facility Code (Site ID)*
	16 – 34	21	1 – 21	Card ID (Serial Number)

*There are not enough unique bits to accommodate both the ID and facility code for 37-bit McGann. Consequently, the reader generates an additional 3 zeros and appends them to the next most significant bits of the facility code.

NOTE: If the reader is configured to output a fixed Wiegand Facility Code, that setting will override the default Wiegand Facility Code settings. This fixed Facility Code setting will not affect native Wiegand tag reads. These configuration settings are stored in non-volatile memory (NVM) until a reset is issued.

Title 21 Specifications Definitions

The information that follows is extracted from the Title 21 specification and is provided for reference only.

Tag Type A

4-bit field currently established to uniquely differentiate California's transponders from transponders that originate from agencies external to the state. In the future, the unassigned bits could be used to recommend a unique North American agency numbering scheme, or to further describe the operational behavior of the transponder. The 4-bit field is defined in decimal notation as follows:

0 – California SOV

2 – Existing Out of State

4 – California HOV2

8 – California HOV3+

1, 3, 9-15 – Unassigned/available for future use

Facility Code This is an 18-bit field used to identify the facility or entity conducting business. Facility Code ranges are assigned based upon the number of transponders that are projected to be utilized. The 18-bit field is defined in decimal notation as shown in Table 16 and Table 17. Facility Codes 75,001 thru 125,000 are reserved for Switchable Tags. Refer to Table 17.

Table 16 – Title 21 Non-Switchable Transponder Facility Codes (Tag Type 0)

Agency	Facility Codes Assigned	Number of Transponders
State of California	0 – 75,000	76,801,024
Sacramento County Dept. of Airports	125,001 – 125,020	20,480
TCA	129,314 – 132,092	2,845,696
SR-91	132,096 – 132,990	916,480
SANDAG 1-15	132,992 – 133,001	10,240
Golden Gate Bridge	133,015 – 133,407	402,432
CTV	134,583 – 134,876	301,056
Port of Oakland	140,000 – 140,001	2,048
LA World Airports	141,000 – 141,042	44,032
BATA	145,000 – 146,974	2,022,400
SENTRI	184,876 – 185,022	150,528
SANDAG 1-15	258,960 – 259,100	144,384
Caltrans ATCAS	260,096 – 262,136	2,089,948

Table 17 – Title 21 Switchable Transponder Facility Codes (Tag Types 0,4,8

Agency	Facility Codes Assigned	Number of Transponders
LA, MTA	75,001 – 75,489	500,736
TCA	80,000 – 80,781	800,768
SR-91	81,000 – 81,024	25,600

Internal Tag ID A 10-bit field used to refer to the unique identification numbers that belong to an assigned Facility Code. For each Facility Code, a block of 1,024 Internal Tag IDs will be assigned within the Transponder ID Number Field.

Title 21 Agencies Out-of-State:

Since the Title 21 standard is an open specification there are other agencies outside of California that utilize the protocol.

Table 18 lists out-of-state Title 21 agencies that have contacted the California Department of Transportation to participate in California's unique definition for the 32-bit Transponder ID Number field.

NOTE: This listing does not ensure that the assignments are unique, as they may have been duplicated by another agency outside of California.

Table 18 – Title 21 Out-of-State Field Definitions (Tag Type 2)

Agency	Tag Type	Facility Codes Assigned	Number of Transponders
Colorado E-470 Public Highway Authority	2	0 – 9,766	10,001,408
Denver International Airport	2	10,000 – 10,029	30,720
Golden Ears Bridge Group, Vancouver, Canada	2	15,000 – 16,000	1,025,024

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