

ILLUSTRATED GLOSSARY

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1. Glossary of Terms and Acronyms

- **Air Interface:** The complete communication link between a reader and a tag including the physical layer, collision-arbitration algorithm, command and response structure, and data-coding methodology.
- **AFI:** Application Family Identifier, bits 18-1F hexadecimal in the EPC memory bank for ISO numbering systems. (see next section of this document)
- **ASCII:** American Standard Code for Information Interchange, is a character encoding standard for electronic communication. Includes uppercase letters (A-Z), numbers (0-9), and symbols (such as “!” and “\”)
- **Attribute bits:** bits 18-1F hexadecimal in the EPC memory bank for GS1 numbering systems.
- **Binary:** a base-2 numbering notation, sometimes denoted by a subscript “2” after the data value (for example, “12” means binary 1).
- **Bit:** the smallest unit of data that a tag chip can process and store. A bit is always in one of two physical states, similar to an on/off light switch. The state is represented by a single binary value, usually a 0₂ or 1₂.
- **Byte:** 8 bits
- **CIN:** Company Identification Number, a unique value assigned by an ISO “Issuing Agency” to identify a company or entity. The RAIN Alliance is an ISO-authorized Issuing Agency and can issue RAIN CINs to organizations encoding tags with the RAIN ISO numbering system.
- **CRC:** cyclic-redundancy check, a data field used by a tag (or reader) to ensure the validity of data communicated by a reader (or tag).
- **EBV-8:** Extensible Bit Vector format – 8 bits (see final section of this document).
- **EPC:** Electronic Product Code. GS1 terminology for the unique product identifier stored in Memory Bank 01. Often used to refer to the entire memory bank (see “EPC memory bank” below). ISO terminology equivalent is “UII” (see below).
- **EPC memory bank:** One of four memory banks on a RAIN RFID tag that stores business information such as the physical item to which the tag is attached. Also known as EPC/UII memory, Memory Bank 01, and MB-01, this memory bank contains the CRC, PC, and EPC/UII (and XPC if supported by the tag chip).
- **GS1:** a neutral, global collaboration platform that brings industry leaders, government, regulators, academia, and associations together to develop standards-based solutions to address the challenges of data exchange.
- **Hexadecimal:** a base-16 numbering notation, sometimes denoted by “0x” preceding the value (for example, “0x1A” means hexadecimal 1A).
- **IC:** integrated circuit, also known as a tag chip.



- **IEC:** International Electrotechnical Commission, an organization that sets international electrical and electronics standards.
- **Interrogator:** a RAIN RFID reader
- **Inventory Round:** The period initiated by a Query command and terminated by either a subsequent Query command (which also starts a new inventory round), a Select command, or a Challenge command.
- **ISO:** International Organization for Standardization. An independent, non-governmental international organization with a membership of 167 national standards bodies.
- **PC Word:** Protocol Control Word, word 1 (bits 10-1F hexadecimal) in the EPC/Ull memory bank. (see next section of this document)
- **Protocol:** a physical layer and a Tag-identification layer specification. In this document, “protocol” specifically refers to the GS1 EPC Radio-Frequency Identity Protocols Generation-2 UHF RFID Standard or ISO/IEC 18000-63 Information technology - Radio frequency identification for item management - Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C. Also commonly known as “Gen2.”
- **Query:** a Gen2 command that initiates an Inventory Round.
- **Sensitivity:** reader sensitivity is the weakest tag signal that a RAIN RFID reader is able to detect. Tag sensitivity is the weakest reader signal that is capable of turning on a RAIN RFID tag.
- **Tag Data:** the business, control, and tag manufacturer information stored in a tag chip.
- **Toggle Bit:** Bit 17 hexadecimal in the EPC/Ull memory bank, also known as the T bit
- **Ull:** Unique Item Identifier, item information beginning at bit 20 hexadecimal in the EPC/Ull memory bank for ISO numbering systems. Ull is the ISO equivalent of the EPC in a GS1 numbering system.
- **UMI:** User Memory Indicator, bit 15 hexadecimal in the EPC/Ull memory bank.
- **Word:** 16 bits
- **XI:** Extended Protocol Control (XPC) Indicator.

2. The PC Word and AFI bits

All standardized numbering systems require encoding the Protocol Control (PC) Word. It is defined by the air interface standard to provide meta-information about the data stored on the tag, including the length of the encoded data and what numbering system is used. The PC Word is stored in Memory Bank 01, typically referred to as “EPC/Ull memory” starting in word 1. Part of its role is to provide a “preview” of the type and amount of data stored elsewhere in the tag memory. The air interface standard is available here: <https://www.gs1.org/standards/rfid/uhf-air-interface-protocol>

When reading a tag as part of an “Inventory Round”, the tag provides the PC Word and EPC/Ull data in its response to the reader. Some readers and reader software do not show the PC Word by default and may need to be configured to do so.

Note GS1 and ISO standards use different terminology – EPC and Ull refer to the same memory location, EPC for GS1 and Ull for ISO.

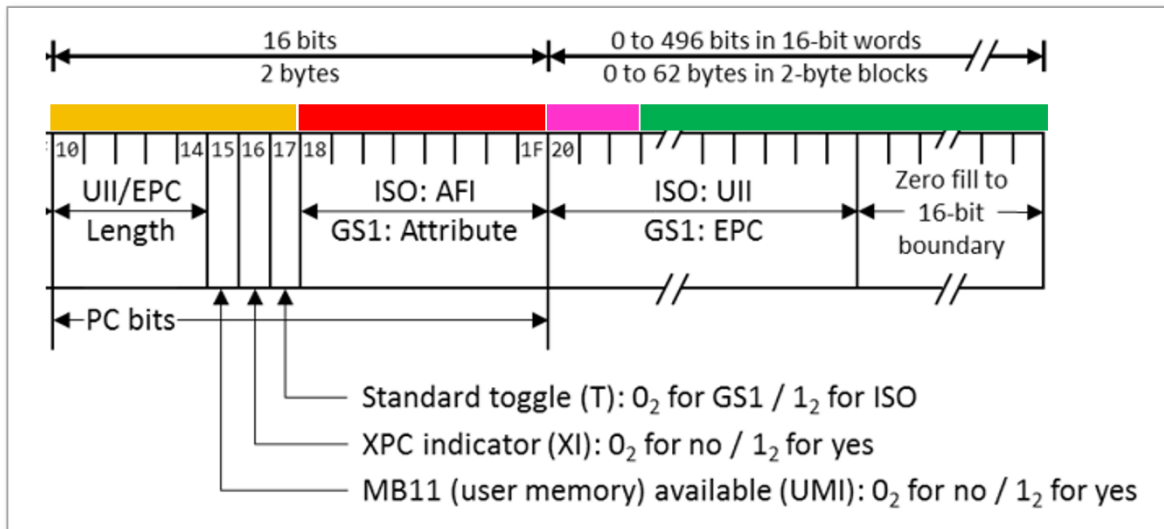


Figure 1. EPC/UII memory bank contents, including the PC Word.

There are 5 information elements encoded in the PC Word:

- **Length:** 5 bits that define the amount of data stored in the EPC/UII memory bank. For example, a tag that has 8 words (128 bits) of available EPC memory, may only be encoded with 6 words (96 bits) of information. The Length bits tell the tag how much of the EPC memory to respond to an inventory command with.
- **User Memory Indicator (UMI):** 1 bit yes/no indicator for the presence of additional User Memory. This bit is determined by the tag IC itself.
- **Extended Protocol Control (XPC) Indicator:** 1 bit yes/no indicator for the presence of advanced features. This bit is determined by the tag IC itself and is set to 0₂ for most RAIN tags.
- **Toggle (T) bit:** 1 bit yes/no indicator for the type of numbering system. Set as 0₂ for GS1 numbering systems by default. Should be changed to 1₂ for ISO numbering systems.
- **Attribute bits / Application Family Identifier:**
 - **For GS1 encoded tags with T=0₂,** current GS1 standards refer to this data field as attribute bits “reserved for future use” and should be set to zero.
 - **For non-GS1 or ISO tags with T=1₂,** this data field is known as the Application Family Identifier (AFI) – it serves to define the numbering system, application or industry of the tag data. The AFI for the RAIN Alliance ISO numbering system is 0xAE (See here for others [ISO/IEC 15961-2 Data Constructs Register](#))

When using the RAIN ISO numbering system, it’s critical to set the Toggle bit (T) to 1₂ and the AFI bits to 0xAE. If you’re not familiar with how to calculate the PC Word, there’s a table of common PC word values for reference at the end of this document.



3. Extensible Bit Vector EBV-8 Encoding

EBV-8 encoding format EBV (Extensible Bit Vector) is a data structure with an extensible range. An EBV is an array of blocks with each block containing a single extension bit followed by a specific number of data bits. For EBV-8, there are 8 bits in one block and each block contains an extension bit followed by 7 data bits. The data value represented by an EBV-8 is simply the bit string formed by the data bits as read from left-to-right, ignoring the extension bits. Because each block has 7 available data bits, an EBV-8 can represent numeric values between 0 and 127 with a single block. To represent the value 128, set the extension bit to 1 in the first block, and append a second block to the EBV-8. In this manner, an EBV-8 can represent arbitrarily large data values. RAIN CIN values are in the range 0 to 99,999,999 so the corresponding EBV-8 encoding will require from 1 to 4 bytes of memory.

Number (i.e. RAIN CIN)		EBV-8 Encoding							
		Byte 1		Byte 2		Byte 3		Byte 4	
		ext	data	ext	data	ext	data	ext	data
0	$2^0 - 1$	0	0000000	n/a	n/a	n/a	n/a	n/a	n/a
1	2^0	0	0000001	n/a	n/a	n/a	n/a	n/a	n/a
127	$2^7 - 1$	0	1111111	n/a	n/a	n/a	n/a	n/a	n/a
128	2^7	1	0000001	0	0000000	n/a	n/a	n/a	n/a
16,383	$2^{14} - 1$	1	1111111	0	1111111	n/a	n/a	n/a	n/a
16,384	2^{14}	1	0000001	1	0000000	0	0000000	n/a	n/a
2,097,151	$2^{21} - 1$	1	1111111	1	1111111	0	1111111	n/a	n/a
2,097,152	2^{21}	1	0000001	1	0000000	1	0000000	0	0000000
268,435,453	$2^{28} - 1$	1	1111111	1	1111111	1	1111111	0	1111111