Thinfilm NFC Barcode Data Format for NFC OpenSense™ & NFC SpeedTap™ 128- & 256-bit NFC Tags

previously known as Kovio® NFC Barcode

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1. INTRODUCTION

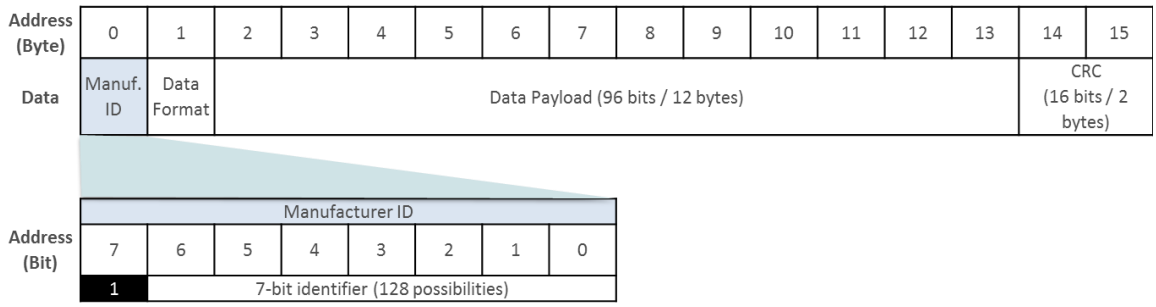
Thinfilm's NFC SpeedTap™ and NFC OpenSense™ products use the NFC Barcode™ protocol, a common NFC protocol supported by top-tier NFC controllers from NXP, Broadcom, Samsung, Sony, Toshiba, and others. NFC SpeedTap and NFC OpenSense tags are passive, 128-bit NFC tags operating at 13.56MHz and using a Tag-Talks-First (TTF) protocol. These NFC tags operate in a read-only mode to transmit 128-bit codes to NFC-enabled devices, such as phones, tablets, PCs, and set-top boxes.

Data in NFC SpeedTap and NFC OpenSense tags is primarily stored in permanent, unalterable read-only memory and may include a number of dynamic bits to reflect the status of connected or integrated sensors and other information that could change over time. Note, however, that because these tags do not receive information via RF, all data transmissions are unidirectional, from tag to reader.

To promote interoperability, NFC SpeedTap and NFC OpenSense tags store data following the NFC Barcode data formats (previously known at Kovio NFC Barcode data formats). These are standardized representations of data so that operating systems and applications can consistently interpret the 128-bit data stream.

2. MEMORY MAP OVERVIEW

The 128-bit NFC Barcode memory map is divided into four main sections: the Manufacturer ID (which always includes a '1' start bit), the Data Format identifier, the Data Payload, and the CRC.



2.1 Manufacturer ID Field

The 8-bit (1-byte) Manufacturer ID field consists of a start bit and a 7-bit ID. Due to the Tag-Talks-First (TTF) format of the NFC Barcode, it is required that the first bit is always a '1' to serve as an identifiable start bit for the NFC controller that is attempting to read the tag. A 7-bit manufacturer ID (based on the least significant 7 bits of the manufacturer IDs specified in the ISO/IEC 7816-6 specification) follows the mandatory '1' start bit. For example, NFC Barcode tags manufactured by Thinfilm under the Kovio brand name (Manufacturer ID 0x37, according to ISO/IEC 7816-6), will have a first byte of 0xB7 (including the '1' start bit).

2.2 Data Format Field

The 8-bit (1-byte) data format identifier describes how a reader should interpret the contents of the payload field. The data format identifier contains two sections: Reserved bits and a Data Type Format. The 3-bit Reserved section is set to '000' for the 128-bit NFC Barcode. The 5-bit Data Type Format allows for 32 possible data types, as defined below.

Address (Bit)	Data Format Identifier							
	7	6	5	4	3	2	1	0
	Reserved			Data type format				

2.2.1 Identifiers for Fixed (ROM) Data Formats

Decimal	Hex	Data Type Format for Fixed (ROM) Data
0	0x00	Reserved for allocation by tag manufacturer
1	0x01	96-bit URL in US-ASCII text, with appended prefix *http://www.*
2	0x02	96-bit URL in US-ASCII text, with appended prefix *https://www.*
3	0x03	96-bit URL in US-ASCII text, with appended prefix *http://*
4	0x04	96-bit URL in US-ASCII text, with appended prefix *https://*
5	0x05	96-bit binary representation of 96-bit Electronic Product Code (EPC), according to the GS1 EPC Tag Data Standard
6 & above	0x06 & above	Reserved for future use

2.3 Data Payload Field

The interpretation of data located in the payload is governed by the contents of the tag's Data Format Field. For the 128-bit NFC OpenSense and NFC SpeedTap tags, the payload length is 96 bits (12 bytes).

2.3.1 Manufacturer Defined ID (0x00)

Code 0x00 is reserved for allocation by the tag manufacturer. It may, as an example, serve as a globally unique identifier within the manufacturer's tag identification system when combined with the tag's manufacturer ID located in Byte 0.

2.3.2 URL Types (0x01-0x04)

For URL data, the 96-bit payload consists of exactly 12 bytes of information, representing 12 7-bit US-ASCII characters. For more information, consult Section 3.2.3 "URI Field" of the NFC Forum "URI Record Type Definition, Technical Specification, version 1.0." The specification can be downloaded after accepting the license at http://www.nfc-forum.org/specs/spec_license

An **optional** terminator byte (0xFE) can be used to indicate the end of a URL with a length less than the maximum allowed in the tag payload area. Note that any payload data following the terminator byte and before the CRC is not to be included as part of the URL. Any data following the terminator byte must, however, be readable as part of the tag's complete 128-bit code. The presence of a terminator byte has no impact on the calculation of the CRC.

Example 1: without 0xFE terminator byte, Result URL http://ab.cd/123xYz

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	B7	03	61	62	2E	63	64	2F	31	32	33	78	59	7A	E8	08
Comment	Thinfilm	URL http://	a	b	.	c	d	/	1	2	3	x	Y	z	CRC	

Example 2: with 0xFE terminator byte, Result URL https://ab.cd/123

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	B7	04	61	62	2E	63	64	2F	31	32	33	FE	14	12	33	2E
Comment	Thinfilm	URL https://	a	b	.	c	d	/	1	2	3	Term	Optional non-URL data		CRC	

2.3.3 GS1 Electronic Product Code (EPC) Data (0x05)

For 96-bit Electronic Product Code (EPC) data, the 96-bit payload consists of a 96-bit binary representation of a 96-bit EPC as defined in the GS1 EPC Tag Data Standard. The latest version can be downloaded directly from GS1 at http://www.gs1.org/gsmp/kc/epcglobal/tds

2.4 CRC Field

For 128-bit tags, the final 16 bits (2 bytes) contain a 16-bit CRC for the previous 14 bytes. This CRC is calculated according to the ISO 14443 Type A CRC defined in Appendix B of the ISO 14443 Part 3 specification. Checking this CRC provides a fairly robust method of identifying code transmission errors. For tags containing a combination of fixed (ROM) and dynamic data, the transmitted CRC will change based on the state of the dynamic bits and will automatically correspond to the tag's combined fixed and dynamic data. No change is required to the NFC Controller to support tags containing both fixed and dynamic data.

Note: The initial bit '1' and 16-bit CRC are considered to be part of each tag's 128-bit code and **must** be included in the data transmission from the NFC Controller to the host, even if the CRC is analyzed and verified by the NFC Controller.

3. REVISION HISTORY

Section	Description
Revision 1.0 (March 31, 2013)	
Global	Initial release
Revision 2.0 (June 23, 2014)	
Global	Update to Thinfilm template
Revision 3.0 (June 8, 2015)	
Global	Add description of terminator value 0xFE for URLs that do not occupy the full payload.
Section 2.3	Added detailed description of Data Payload Field options
Revision 3.1 (October 8, 2015)	
Global	Updated name to Thinfilm NFC Barcode. Noted that the product was previously identified as Kovio NFC Barcode. Readers: please note this is the same product and only the name has been updated.
Revision 3.2 (December 16, 2015)	
Global	Added references to NFC OpenSense and NFC SpeedTap products, which both follow the NFC Barcode protocol and NFC Barcode data format.
Revision 3.3 (May 26, 2017)	
Global	Updated template to reflect new Thinfilm branding.