



PRELIMINARY

Features

- Reliable Half-Duplex (HDX) Low Frequency (LF) Communications Format
- 64 Bits For Data / Identification Storage
- 134.2 kHz Operating Frequency
- FSK Modulation
- Energy Harvesting Battery-Free Wireless Power
- 16 Bit CRC Error Detection Code Generator
- 10 Year Data Retention

Applications

- Inventory Management
- Ingress/Egress Discovery
- Real-time Container Tracking
- Manufacturing Production Flow Control
- Vehicle Identification
- Security Access Administration
- High Value Asset Monitoring

Description

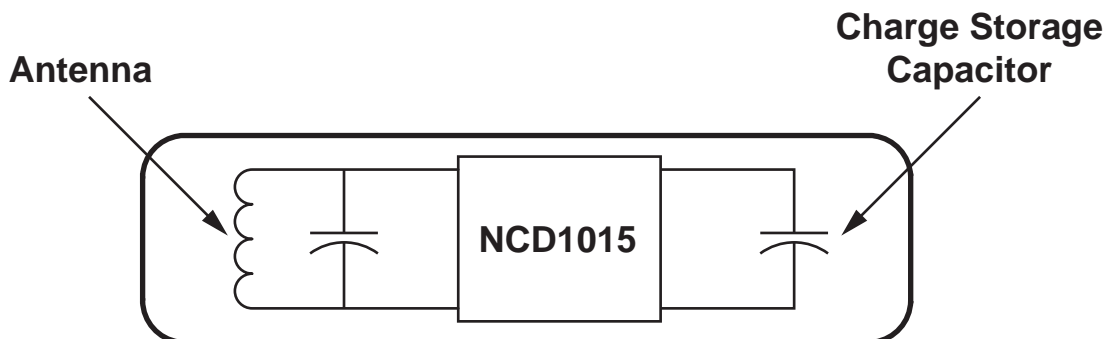
The NCD1015ZG is a passive, glass-encapsulated, cylindrical, low frequency, half-duplex, read-only radio frequency identification (RFID) transponder that operates at a nominal resonant frequency of 134.2kHz. With 64-bits of pre-programmed identification data storage and a 16-bit CRC error checking code generator, the transponder supports ISO 11784 and ISO 11785 standards.

Using the power acquired from harvesting the RF energy transmitted by the RFID reader, the passive transponder responds by sending out a 128-bit packet that contains the stored 64-bit data, a 16-bit CRC-CCITT error checking code, and the overhead bits necessary to ensure transmission recognition. Transmission of the digital data from the transponder to the reader utilizes an FSK modulation technique where a logic 0 is represented by a 16 cycle burst of 134.2 kHz while a logic 1 uses 124.2 kHz.

Ordering Information

Part #	Description
NCD1015ZG	50mm HDX 64-bit RFID Data Transponder, Pre-programmed ID Code: 150 Units per Box (21cm x 21cm x 6.5cm) Bit 1 = 0 :: Non-animal Bits 2 - 16 = 0x0000 Bits 17 - 26 = 0x3D2 (978 _d) Bits 27 - 64 :: Unique Identification Code - value will be incremented at the factory to provide a unique code for each device. Maximum number of unique values = $2^{38} - 1 = 0x3FFFFFFF$ (ID Code = 0 not used)
NCD1015ZGC	50mm HDX 64-bit RFID Data Transponder. Contact the factory for customizable features.

Block Diagram



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1. Specifications

1.1 Operating Conditions

Parameter	Symbol	Minimum	Maximum	Unit
Operating Temperature	T_A	-20	+60	°C
Storage temperature	T_{STG}	-40	+60	°C

1.2 Electrical Specifications

Unless otherwise specified, minimum and maximum values are guaranteed by production testing or design. Typical values are characteristic of the device at 25°C, and are the result of engineering evaluations. They are provided for informational purposes only and are not guaranteed by production testing.

Parameter	Conditions	Symbol	Minimum	Typical	Maximum	Unit
Charging duration required for transmission			15	50	-	ms
Low Bit Frequency	$T_A = 25^\circ\text{C}$	f_0	134	134.6	135	kHz
	$-20^\circ\text{C} \leq T_A \leq 60^\circ\text{C}$		133	-	136	
High Bit Frequency	$T_A = 25^\circ\text{C}$	f_1	123	124.6	126	kHz
	$-20^\circ\text{C} \leq T_A \leq 60^\circ\text{C}$		122	-	127	
Data Retention			10	-	-	Years

2. Functional Overview and Description

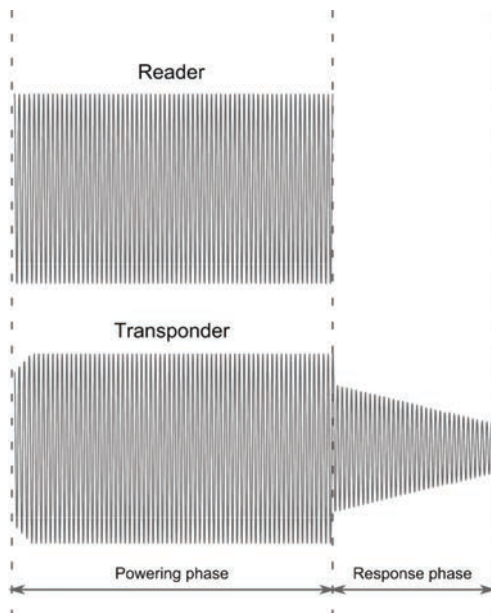
2.1 Overview

The reader and the pre-programmed NCD1015ZG transponder comprise the two elements of a half-duplex wireless communications system operating in a sequential mode with time-separated power and data transmission cycles. Power transfer to the transponder (tag) is accomplished by electromagnetic coupling of the transponder and reader antennae.

2.2 Power Transfer

As shown below in Figure 1, an activation field sourced by the reader supplies power to the transponder at the beginning of a read request. The reader generates an electromagnetic field for typically 50 ms using an activation frequency of 134.2 kHz to energize the resonant circuit of the transponder. During this Powering Phase, circuitry within the transponder rectifies the induced voltage to charge an internal storage capacitor. Energy held by the storage capacitor provides the means by which the transponder transmits its stored data. The reader terminates the activation field to indicate it is ready to receive data from the transponder.

Figure 1: Activation and Read Phases: Voltage at the Reader's Exciter and Transponder Coils



2.3 Communication Interface - Tag to Reader

Frequency Shift Keying (FSK) modulation is employed by the NCD1015ZG to transmit the stored data immediately after detecting the end of the reader's activation field. As can be seen in Figure 1, the tag's transmit (Response phase) directly follows the Powering phase.

Transfer of the stored digital information is accomplished by using two discrete frequencies, one for a logic "1" (High) and another for a logic "0" (Low). The nominal frequencies used for data transmission are:

- $f_1 = 124.2\text{kHz}$ is for logic high data encoding
- $f_0 = 134.2\text{kHz}$ is for logic low data encoding

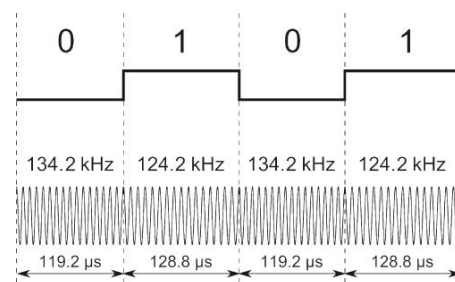
2.3.1 Data Bit Structure

Data bits are transmitted as 16 cycles of their respective frequency. Because a logic high (1) data bit uses a lower frequency than that for a logic low (0), the duration of a 1 bit is longer than a 0 bit. The duration for logic 1 and logic 0 bits is given below.

- $t_{d1} = 16/f_1 = 16/124.2\text{kHz} = 128.8\mu\text{s}$
- $t_{d0} = 16/f_0 = 16/134.2\text{kHz} = 119.2\mu\text{s}$

Figure 2 illustrates the FSK encoding principle used to transmit the stored data.

Figure 2: FSK Transmission Used During the Read Phase



2.3.2 Transponder Data Rate and Data Coding

The data coding is based on the NRZ method thus achieving an average data rate of ~8kbit/s based on an equal distribution of '0' and '1' data bits.

2.3.3 Completion of Transmission

Following the output of the last bit, the transponder deactivates.

2.4 Transmission Protocol

2.4.1 Transponder - Response Data Format

An RFID answer by the NCD1015ZG contains a Header, the identification DATA, a CRC value, and a Trailer.

Framed as shown below in Figure 3 the transmitted signal has a fixed length of 128 bits. The Header consists of a 16-bit Pre-Bits leader followed by an 8-bit Start byte. Following the CRC error checking value is the Trailer consisting of an 8-bit Stop byte followed by the 16-bit Post.

Depending on the value of the sixteenth Data bit, logical data address [48], the Stop byte value changes. When the identification data stored in the NCD1050ZP complies with ISO 11784, data bit 16 as defined in ISO 11784 will be 0 and the Stop byte value will be 0x7E. For identification data not compliant with ISO 11784 the Stop byte value will be determined by the value stored in the sixteenth bit of the data.

The Data, CRC, Stop and Post data will be transmitted starting with the LSB and ending with the MSB.

Figure 3: Tag Response Frame Format

Pre-Bits		Start		Data		CRC		Stop		Post	
1	16	17	24	25 (LSB)	88	89 (LSB)	104	105 (LSB)	112	113 (LSB)	128

All signals are coded [MSB:LSB].

- Pre-Bits [15:0] . . . = 0x0000
- Start Byte [7:0] . . = 0x7E
- Data [63:0] = Data
- CRC [15:0] = Data CRC
- Stop Byte [7:0] . . = 0x7E - Data bit 16 = 0[‡]
- Stop Byte [7:0] . . = 0x1E - Data bit 16 = 1[‡]
- Post Bits [15:0] . . = 0x0000

[‡] Data bit position as defined in ISO 11784

2.4.2 CRC - CCITT Error Checking

The CRC generator circuitry creates a 16 bit CRC to ensure the integrity of the data packets received by the transponder. The reader and transponder use the CRC-CCITT (Consultative Committee for International Telegraph and Telephone) algorithm for error detection.

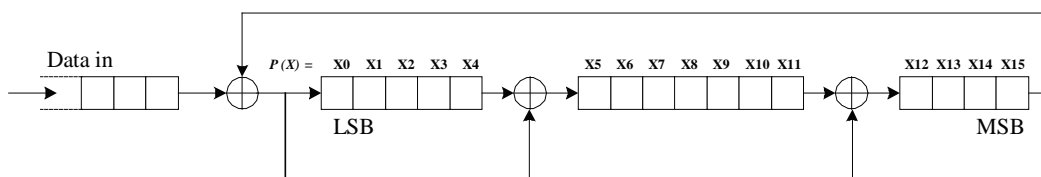
The 16-bit cyclic redundancy code is calculated using the following polynomial:

$$P(x) = x^{16} + x^{12} + x^5 + x^0$$

The implemented version of the CRC check has the following characteristics:

- Reverse CRC-CCITT 16 as described in ISO/IEC 13239 and used in ISO/IEC 11784/11785.
- The CRC 16-bit shift register is initialized to all zeros (0x0000).
- The incoming data bits are XOR-ed with the MSB of the CRC register and is shifted into the register's LSB.
- After all data bits have been processed, the CRC register contains the CRC-16 code.
- Reversibility - The original data, together with associated CRC, when fed back into the same CRC generator will regenerate the initial value (all zero's).

Figure 4: Schematic Diagram of the 16-Bit CRC-CCITT Generator



3. Mechanical Data

3.1 Dimensions and Material

Parameter	Min	Typ	Max	Unit
Length	48	51	53	mm
Diameter	14.8	15	15.2	mm
Weight	-	20	-	g
Case Material	Borosilicate Glass			
Protection Class	Hermetically Sealed			
Hydrolytic Class (ISO 719)	HGB 1			
Acid Class (DIN 12116)	S 1			
Alkali Class (ISO695)	A 2			

3.2 Mechanical Shock

Drop (impact) test

The units are qualified following the drop (impact) test described below:

- Standing up, with the device up and down, push the unit to force it to fall down: 5 times each
- Drop from 5cm starting horizontally
- Drop from 5cm starting standing up, with the device up and down

All the impacts performed dropping the units onto a 3cm thick chipboard table

3.3 Thermal Stress

Temperature cycling: 500 times [65°C => -40°C => 65°C]

- Transit time: 30 minutes
- Dwell time at 65°C: 60 minutes
- Dwell time at -40°C: 60 minutes

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