



SIC73F1

134.2 kHz, Multipage 1360-bit R/W HDX RFID Transponder
REV 1.3

Features Summary

Highlight Features

- Half-Duplex contactless read/write data transmission
- Multipage Transponder (MPT)
- On-chip rectifier and voltage limiter

Interface and Peripheral

- Compliant with ISO 11784/11785 HDX Animal tag ID data
- Support to SEMI E144-0312
- Uplink modulation: FSK (Frequency Shift Keying)
- Uplink data rate: 134.2 kHz (data0) and 124.2 kHz (data1)

Applications

- Wafer carrier tracking
- Access Control
- Industrial

Memory

- 1,360 bits EEPROM
- 17 pages read/write memory
- 100,000 erase/write cycles
- 10 years non-volatile data retention

Operating Conditions

- Carrier frequency f_c is 134.2 kHz
- Operating temperature: -25°C to 85°C

Package

- Glass Transponder 32 mm (Bio-glass with black epoxy)

Revision History

Revision	Date	Change/Update Comment
1.0	15 Oct 2022	Preliminary release
1.1	5 May 2023	Update Ordering information, Package dimension and Packing specification
1.2	31 Jul 2024	Update document title name and Table 5-3
1.3	27 Sep 2024	Update Ordering information

Ordering information

Part No.	Description	Package	Standard Packing
PF1AGU63G10SUF120T1	SIC73F1-20, Multipage 1360-bit R/W memory HDX LF RFID Glass Transponder 32mm, TnR, RFID	Glass Transponder	2,000 pcs/Reel
PF1AGU63G10SUF120C8	SIC73F1-20, Multipage 1360-bit R/W memory HDX LF RFID, Glass Transponder 32mm, Canister, RFID TAG	Glass Transponder	900 pcs/Canister

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0. Notation

0.1 Styles and Fonts for key words

This part defines styles and fonts used for the key words throughout this document. The key words are names of signal, register, pin, state of operation and command. The styles, fonts, and their indications are shown in Table 0-1.

Table 0-1: Style and Fonts key word

Symbol	Indication
<i>Signal</i>	Signal name
Register	Register name or Bit name
pin RX	Pin name
<i>“State of Operation”</i>	State of operation
<i>Command</i>	Command name for RF interface
“Flag”	Flag name in response state

- To refer to a register address and a value in a register, a hexadecimal number proceeding with letter “0x” is used, for example 0x0A.
- To refer to a bit located in a register address, a symbol “.” following by a number reflecting the bit location starting from 0 to 7 is used. For example, 0x0A.0 refers to bit 0, least significant bit, in the register 0x0A.
- To refer to a set of consecutive bits located in a register address, a format “. [msb:lsb]” is used after a register value. For example, a value of 0x0A.[3:0] refers to bit 3, 2, 1, and 0 in the register 0x0A.
- To refer to a binary value in some registers, the letter “b” is placed at the end of the binary number, for example “1010b”.
- To refer to logic level, the number in single quote ‘1’ and ‘0’ are used to refer to binary logic level.

0.2 Abbreviation

Table 0-2: Abbreviation

Abbreviation	Term
AFE	Analog-Front-End
ASK	Amplitude shift keying
CMD	Command
CRC	Cyclic redundancy check
DBCC	Data Block Check Character
EEPROM	Electrically Erasable Programmable Read-Only Memory
FBCC	Frame Block Check Character
HDX	Half Duplex
HV	High Voltage
Lock	Permanently disable memory programming
LSB	Least significant bit
MPT	Multipage Transponder
MSB	Most significant bit
NRZ	Non return to zero
POR	Power on Reset
PWE	Pulse Width Encoding
RF	Radio Frequency
Rx	Receiver
T _{amb}	Ambient Temperature
Tx	Transmitter

1. Functional Overview

SIC73F1 is a contactless RFID multipage read/write transponder. The transponder communication protocol is half-duplex 134.2 kHz. SIC73F1 is recommended for industrial tracking.

The transponder is powered by harvesting energy from a 134.2 kHz magnetic field via an external coil, which together with the integrated capacitor.

1.1 Details block diagram

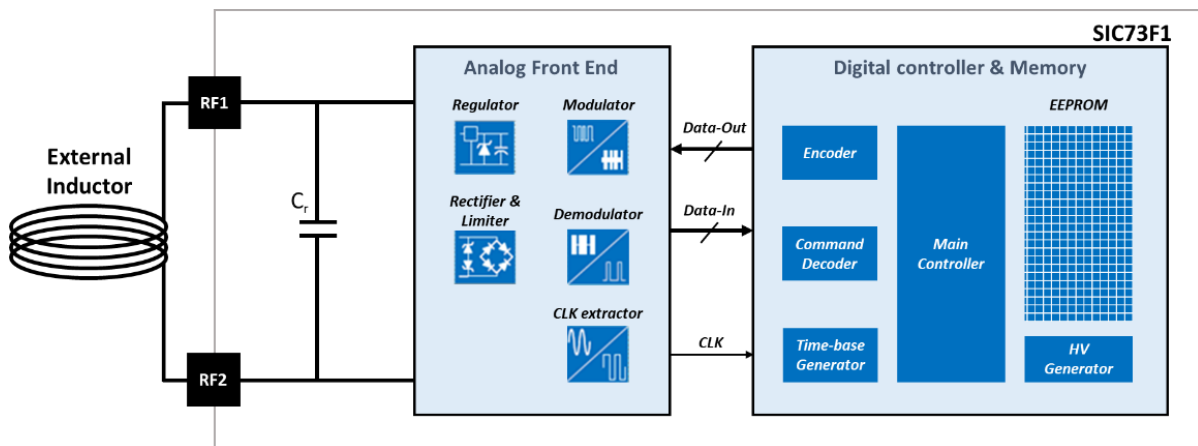


Figure 1-1: SIC73F1 block diagram

1.2 Block component description

1.2.1 Analog Front End (AFE)

The SIC73F1 Analog Front End receives power and data from coupling of an RF signal through an external parallel LC resonant circuit known as an antenna circuit. The AFE creates the IC's power supply and handles the bidirectional data communication with the reader or scanner unit.

The SIC73F1 consists of the following blocks:

- Full wave Bridge Rectifier**
 The Bridge Rectifier with an internal decoupling converts the induced AC signals to a proper DC level for the entire chip.
- Current-Bias Circuit, POR, and Series Regulator**
 The Current-Bias Circuit works with the Series Regulator to generate a stabilized supply for the digital, and memory. The POR operates by detecting the supply level crossing a valid operating threshold during system power-up.
- The RF Limiter and Load Modulator**
 The RF limiter is used to protect the chip from damage caused by a tag is being present in an extremely strong RF field. The signal during the load modulation threshold of the RF limiter is also controlled by the modulation signal during load modulation or the "uplink", thus, amplitude modulating the reader's coil signal.

- **Demodulator**

The envelope of the induced RF signal is encoded with data by the reader during the “Downlink”, SIC73F1 detects changes in the envelope of the signal and converts them into a digital signal by the demodulator.

- **Clock Extractor**

The clock extractor generates a system clock reference corresponding to the RF field frequency. The clock is used for timing of the state machines inside the chip.

1.2.2 Digital controller and memory

- **Command Decoder**

The demodulated signal from the demodulator is further decoded into logical data by the command decoder. Decoded logical data is checked for a valid format for Write mode or the “Downlink”.

- **Controller State Sequencer**

The sequencer performs the following functions:

- Load chip’s configuration data from the memory at initialization state
- Control Read/Write data from/to the memory
- Interpret instruction and data from the command decoder and execute a valid one

- **Encoder**

The encoder encodes the baseband’s bit-stream data into an appropriate format for RF transmission.

1.2.3 Memory

- **EEPROM**

The memory is non-volatile Electrically Erasable Programmable Read-Only Memory (EEPROM) and has a capacity of 1360 bits.

- **HV generator**

The high-voltage generator is included providing a voltage to erase or program data into the memory.

2. Specification

2.1 Absolute Maximum Rating

Conditions above the listed maximum ratings may cause permanent damage to the device. Exposure to the absolute maximum rating conditions for an extended period may affect the device reliability. Only one absolute maximum rating can be applied at a time.

Table 2-1: Absolute Maximum Rating

Parameter	Rating
Operating temperature range	-25 °C to +85 °C
Programming temperature range	0 °C to +70 °C
Storage temperature range	-40 °C to +125 °C

2.2 Electrical Characteristic

Table 2-2: AFE Characteristic

Parameter	Description	Min	Typ	Max	Unit	Conditions
T _{op}	Operating Temperature	-25	+25	+85	°C	
f _{op}	RF operating frequency		134.2		kHz	
f _{mod0}	Modulation frequency data '0'	132.7	134.2	135.7	kHz	
f _{mod1}	Modulation frequency data '1'	122.2	124.2	126.2	kHz	f _{mod0} = 134.2 kHz

Table 2-3: EEPROM Characteristic

Parameter	Description	Min	Typ	Max	Unit	Conditions
MEM	Memory		1360		bits	MPT functionality
t _{ret}	EEPROM Data Retention	10			Years	T _{amb} = +55°C
N _{cy}	EEPROM write cycles	100k			Cycles	

4. Communication

4.1 Downlink Mode (Interrogator to Transponder)

The communication related to telegrams from the reader/interrogator to the transponder/tag is called “Downlink mode”. All the advanced features of the SIC73F1 are exercised only by the downlink operation. After the initialization state, the transponder enters the “Downlink Mode” when the reader starts sending commands string by switching the RF field on and off in pre-defined intervals within the downlink window.

Figure 4-1 describes the Pulse Width Encoding (PWE) scheme of the downlink communication. The time interval between two adjacent field gaps defines the “ON” phase, which determines whether it is a “0” or a “1” being transmitted. The pulse width pattern is constantly measured and interpreted by the command interpreter during the downlink operation.

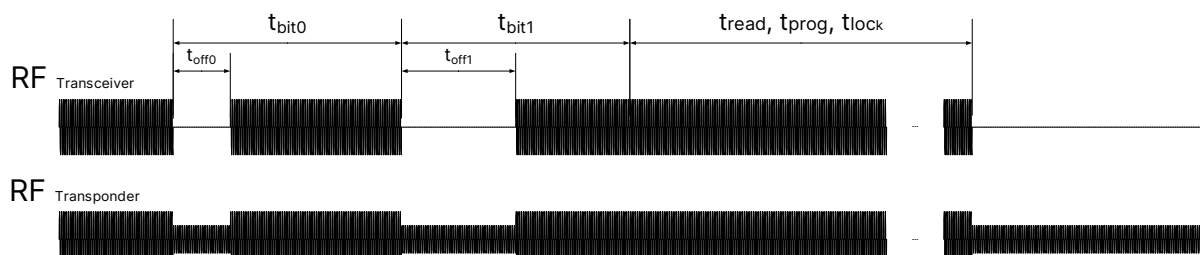


Figure 4-1: RF protocol of reader to transponder

Table 4-1: Downlink timing characteristic

Characteristic at operating frequency (f_{op}) 134.2 kHz

Parameter	Description	Min	Typ	Max	Unit
t_{charge}	Charging (installation) time	15	50		ms
t_{off0}	Bit '0' RF off time	0.20	0.30	0.69	ms
t_{off1}	Bit '1' RF off time	0.90	1.00	1.80	ms
t_{bit0}	Data Rx bit '0' time	1.95	2.00	2.10	ms
t_{bit1}	Data Rx bit '1' time	1.95	2.00	2.10	ms
t_{read}	Execute time for General Read Page command		0		ms
t_{prog}	Execute time for General Program Page command	15		20	ms
t_{lock}	Execute time for Lock Page command	15		20	ms

4.2 Uplink mode (Transponder to Interrogator)

In the Uplink mode, the transponder transmits telegram data back to the Reader, using FSK modulation. This mode starts after the RF field turns off. The typical data bit 0 and 1 are represented by transmitting a resonant frequency of 134.2 kHz and 124.2 kHz, respectively. Each bit is coded by the NRZ method and occupies 16 carrier frequency cycles. The average of the data rate is 8 kbit/s.

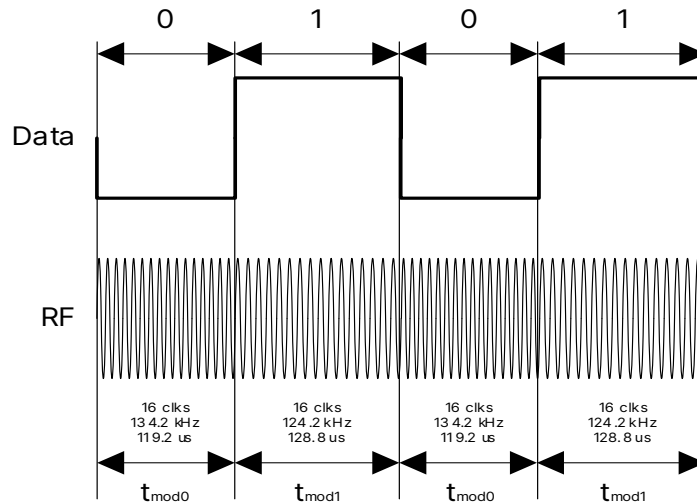


Figure 4-2: RF protocol of transponder to interrogator

Table 4-2: Uplink timing characteristic

Characteristic at operating frequency (f_{op}) 134.2 kHz

Parameter	Description	Min	Typ	Max	Unit
t_{mod0}	Data Tx bit '0' duration	117.9	119.2	120.6	us
t_{mod1}	Data Tx bit '1' duration	126.8	128.8	130.9	us

5.1 Charge-only Read

Upon successful operation, the SIC73F1 returns 80 bits of the data stored on only page 1. The bit sequence starts from the LSB to the MSB.

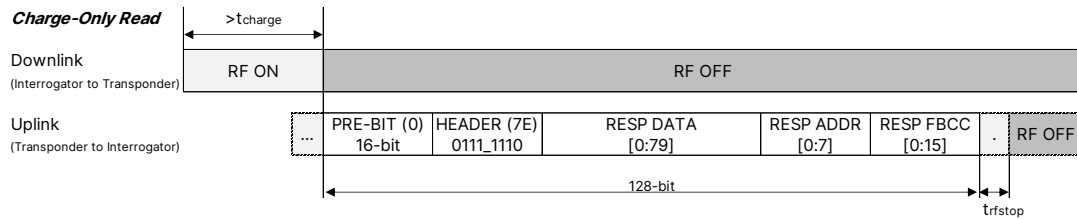


Figure 5-2: Charge-only Read sequence

Table 5-1: Charge-only Read structure

	Structure		Values	Status	Description/ Note
Downlink	REQ ADDR	CMD	[0:1] -	-	Command characteristic
		PAGE	[0:5] -	-	Memory page for accessing
	REQ DATA		[0:79] -	-	Data for writing
	REQ FBCC		[0:15] -	-	Downlink Frame protection
	Execute time			> t_{charge}	-
Uplink	PRE-BIT		[0:15] 0000 0000 0000 0000b	-	16 bits of data '0'
	HEADER		[0:7] 0111 1110b	-	-
	RESP DATA		[0:79] Data in Page 1	-	Data for responding
	RESP ADDR	[0:7] 0010 0000b	Pass	Page 1 is unlocked	
		[0:7] 0110 0000b	Pass	Page 1 is locked	
	RESP FBCC		[0:15] CRC-CCITT	-	Uplink Frame protection
Uplink waiting time			> t_{rfstop} (105 us)	-	Waiting time for sending the next command after the last bit of uplink is sent <i>Note: operating frequency (f_{op}) 134.2 kHz</i>

5.2 General Read Page

Upon successful operation, the SIC73F1 returns the data stored in the memory with the page defined by PAGE. The bit sequence starts from the LSB to the MSB.

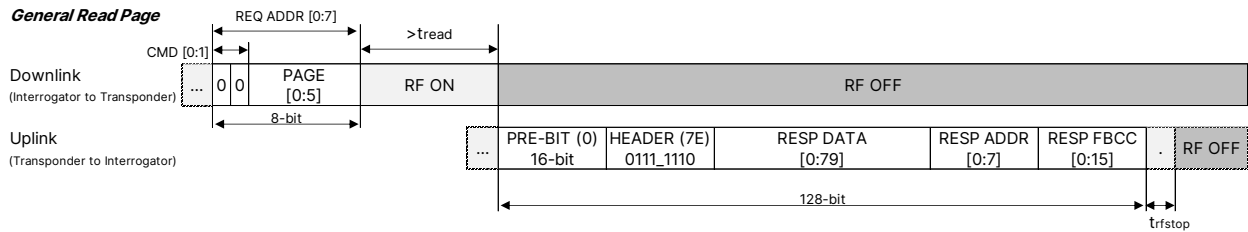


Figure 5-3: General Read Page sequence

Table 5-2: General Read Page structure

	Structure		Values	Status	Description/ Note
Downlink	REQ ADDR	CMD	[0:1] 00b	-	Command characteristic
		PAGE	[0:5] XX XXXXb	-	Memory page for accessing
	REQ DATA		[0:79] -	-	Data for writing
	REQ FBCC		[0:15] -	-	Downlink Frame protection
	Execute time			> t_{read}	-
Uplink	PRE-BIT		[0:15] 0000 0000 0000 0000b	-	16 bits of data '0'
	HEADER		[0:7] 0111 1110b	-	-
	RESP DATA		[0:79] Data in Page X or Data in Page 17 in case of $X \geq 17$	-	Data for responding
	RESP ADDR	[0:7]	00XX XXXXb	Pass	Unlocked Page X was read
		[0:7]	01XX XXXXb	Pass	Locked Page X was read
		[0:7]	0010 0010b	Fail	Unlocked Page 17 was read because of $X > 17$
		[0:7]	0110 0010b	Fail	Locked Page 17 was read because of $X > 17$
RESP FBCC		[0:15] CRC-CCITT	-	Uplink Frame protection	
Uplink waiting time			> t_{rfstop} (105 us)	-	Waiting time for sending the next command after the last bit of uplink is sent <i>Note: operating frequency (f_{op}) 134.2 kHz</i>

5.3 General Program Page

Upon successful operation, the SIC73F1 returns the data written into the memory. The bit sequence starts from the LSB to the MSB.

If the write operation is not successful, the transponder will send out the corresponding error responding as shown in table 6-3.

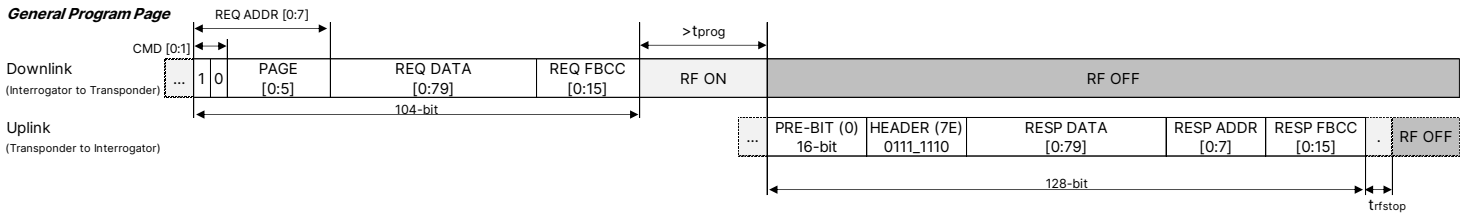


Figure 5-4: General Program Page sequence

Table 5-3: General Program Page structure

	Structure		Values	Status	Description/ Note
Downlink	REQ ADDR	CMD	[0:1] 10b	-	Command characteristic
		PAGE	[0:5] XX XXXXb	-	Memory page for accessing
	REQ DATA	[0:79]	Data 80 bits	-	Data for writing
	REQ FBCC	[0:15]	CRC-CCITT	-	Downlink Frame protection
	Execute time		> t_{prog}	-	-
Uplink	PRE-BIT	[0:15]	0000 0000 0000 0000b	-	16 bits of data '0'
	HEADER	[0:7]	0111 1110b	-	-
	RESP DATA	[0:79]	Data in Page X or Data in Page 17 in case of $X \geq 17$	-	Data for responding
	RESP ADDR	[0:7]	10XX XXXXb	Pass	Page X was programmed
		[0:7]	01XX XXXXb	Fail	Page X is locked
		[0:7]	00XX XXXXb	Fail	Programming Page X was not executed because field strength is too low
		[0:7]	1000 0000b	Fail	Programming Page X was unsuccessful because an error found during the programming execution.
		[0:7]	0010 0010b	Fail	Programming Page X was not executed because of $X > 17$, and Page 17 is unlocked
	[0:7]	0110 0010b	Fail	Programming Page X was not executed because of $X > 17$, and Page 17 is locked	
	RESP FBCC	[0:15]	CRC-CCITT	-	Uplink Frame protection
Uplink waiting time		> t_{rfstop} (105 us)	-	Waiting time for sending the next command after the last bit of uplink is sent	

Note: operating frequency (f_{op}) 134.2 kHz

5.4 Lock Page

This command is used for locking any page. Upon successful operation, the locked page cannot re-program data and unlock.

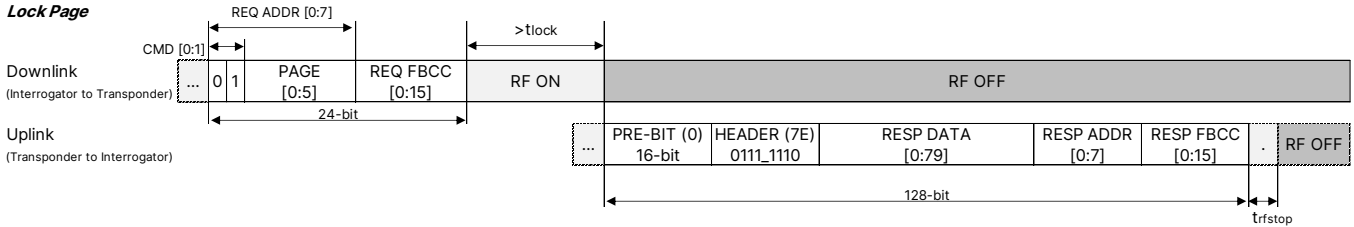


Figure 5-5: Lock Page sequence

Table 5-4: Lock Page structure

	Structure		Values	Status	Description/ Note	
Downlink	REQ ADDR	CMD [0:1]	01b	-	Command characteristic	
		PAGE [0:5]	XX XXXXb	-	Memory Page X for accessing	
	REQ DATA		[0:79]	-	Data for writing	
	REQ FBCC		[0:15]	CRC-CCITT	-	Downlink Frame protection
	Execute time			> t_{lock}	-	-
Uplink	PRE-BIT		[0:15]	0000 0000 0000 0000b	-	16 bits of data '0'
	HEADER		[0:7]	0111 1110b	-	-
	RESP DATA		[0:79]	Data in Page X or Data in Page 17 in case of $X \geq 17$	-	Data for responding
	RESP ADDR	[0:7]	01XX XXXXb	Pass	Page X was locked	
		[0:7]	00XX XXXXb	Fail	Locking of Page X was not executed because field strength is too low	
		[0:7]	0000 0000b	Fail	Locking Page X was unsuccessful because field strength dropped during the locking execution	
		[0:7]	0100 0000b	Fail	Locking Page X was unsuccessful because an error found during the locking execution or Page X was previously locked	
		[0:7]	0010 0010b	Fail	Locking of Page X was not executed because of $X > 17$, and Page 17 is unlocked	
		[0:7]	0110 0010b	Fail	Locking of Page X was not executed because of $X > 17$, and Page 17 is locked	
	RESP FBCC		[0:15]	CRC-CCITT	-	Uplink Frame protection
Uplink waiting time			> t_{rfstop} (105 us)	-	Waiting time for sending the next command after the last bit of uplink is sent <i>Note: operating frequency (f_{op}) 134.2 kHz</i>	

6. Package information

6.1 Glass transponder 32 mm

6.1.1 Package dimension

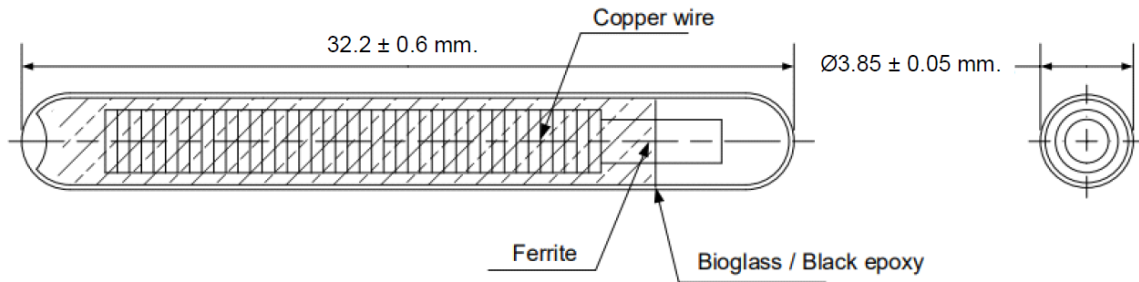


Figure 6-1: Drawing and dimension

Table 6-1: Package dimension and information

Item	Parameter	Value	Tolerance	Unit
Glass transponder	Length	32.2	± 0.60	mm
	Diameter	3.85	± 0.05	mm
	Wire material	Cu	-	-
	Glass type	Bio-glass	-	-

7. Packing Specification



Figure 7-1: Product orientation and carrier tape dimension

Table 7-1: Carrier tape dimension

Item	Parameter	Value	Tolerance	Unit
Pocket	Length	6.11	± 0.10	mm
	Width	33.00	± 0.10	mm
	Depth	4.30	± 0.10	mm
	Pitch	8.00	± 0.10	mm
Carrier tape	Width	44.00	± 0.30	mm
	Thickness	0.30	± 0.30	mm

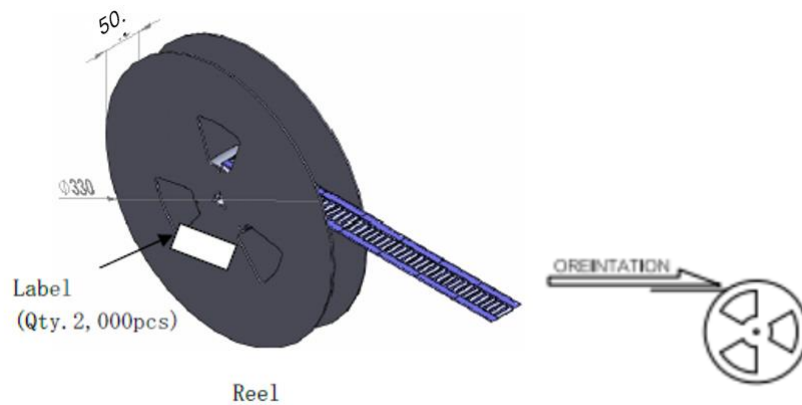


Figure 7-2: Reel dimension

Table 7-2: Reel dimension

Item	Parameter	Value	Tolerance	Unit
Reel	Diameter	330.00	± 2.00	mm
	Hub diameter	63.00	± 1.00	mm
	Width	50.40	Max	mm
	Color	Black	-	-

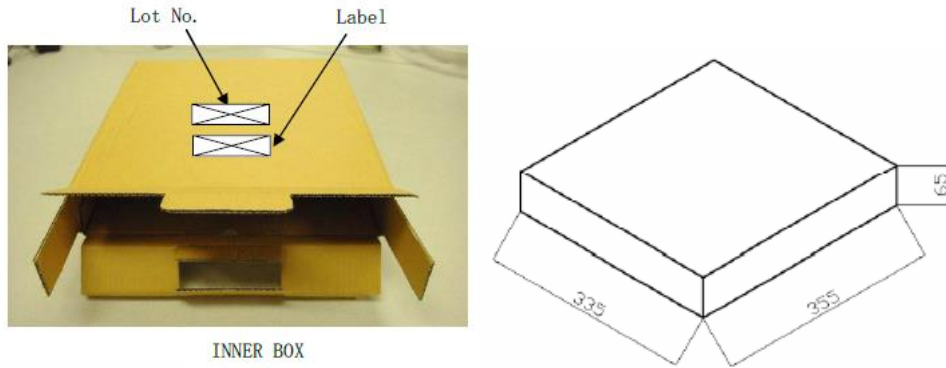


Figure 7-3: Box dimension

Table 7-3: Packing information and box dimension

Item	Parameter	Value	Tolerance	Unit
Packing	PQ (Packing Quantity)	2,000	-	pcs/reel
	Reel per box	1	-	reel
Box	Length	355	-	mm
	Width	335	-	mm
	Hight	65	-	mm

8. Disclaimer

- The information described herein is subject to change without notice.
- Although the IC contains a static electricity protection circuit, static electricity or voltage that exceeds the limit of the protection circuit should not be applied.
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