TEXAS INSTRUMENTS

Tag-it HF Transponder Inlays

Reference Guide

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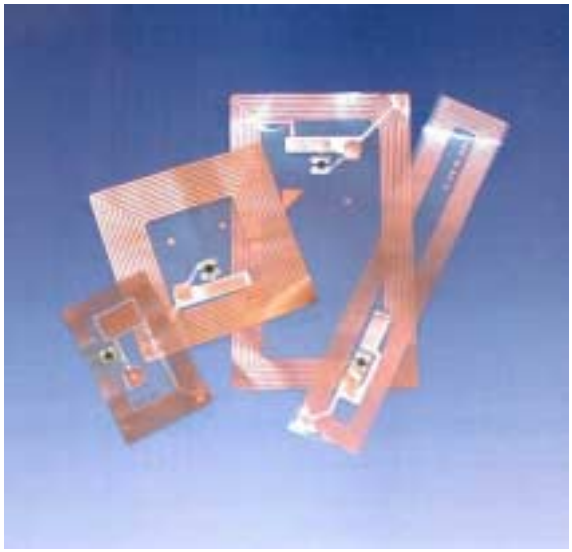
TI-RFid
A TEXAS INSTRUMENTS TECHNOLOGY

Edition One – October 2001

This is the first edition of this reference guide. It contains a description of the Tag-it HF Inlays, their specifications, dimensions and instructions for further handling.



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Read This First

About This Guide

This reference guide for the Tag-it HF Inlays is designed for use by TI partners who are engineers experienced with Radio Frequency Identification Devices (RFID).

Regulatory, safety and warranty notices that must be followed are given in Chapter 4.

Conventions

WARNING:

A WARNING IS USED WHERE CARE MUST BE TAKEN OR A CERTAIN PROCEDURE MUST BE FOLLOWED, IN ORDER TO PREVENT INJURY OR HARM TO YOUR HEALTH.

CAUTION:

This indicates information on conditions which must be met, or a procedure which must be followed, which if not heeded could cause permanent damage to the equipment or software.

Note:

Indicates conditions which must be met, or procedures which must be followed, to ensure proper functioning of the equipment or software.

Information:

Indicates information which makes usage of the equipment or software easier.

If You Need Assistance

For more information, please contact the sales office or distributor nearest you. This contact information can be found on our web site at:

http://www.ti-rfid.com.

Document Overview

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Chapter 1

Introduction

This chapter introduces you to the Tag-it HF Transponder Inlays.

Topic Page

1.1 General

The **Tag-it HF** Inlay family of Texas Instruments RFID transponders with various available inlay shapes forms the basis of consumable smart labels for use in markets requiring quick and accurate identification of items, such as:

- express parcel delivery,
- airline boarding pass and baggage handling,
- electronic ticketing,
- anti-counterfeit prevention,
- distribution logistics
- building access badges
- asset tagging

The passive (no battery) transponder inlays are thin and flexible, offer a general purpose read/write capability and are designed to be easily converted into paper or plastic labels.

The inlay is supplied on a polymer tape substrate, one web wide and delivered on reels. This allows an easy integration into existing label manufacturing processes to produce disposable labels.

User data is written to and read from memory blocks using a non-volatile EEPROM silicon technology. Each block is separately programmable by the user and can be locked to protect data from modification. Once the data has been 'locked' then it cannot be changed.

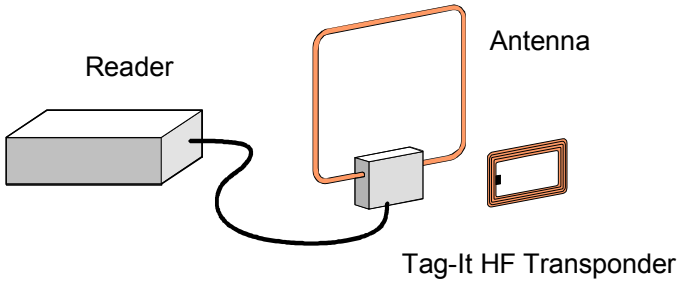
To give some examples, information about delivery checkpoints, place of origin/destination, pallet assignments, inventory numbers and even transportation routes can be coded into the transponder.

Multiple Tag-it HF transponder Inlays, which appear in the Readers RF field, can be written to and read from by using the **S**imultaneous **ID**entification (SID) number, which is programmed and locked at the factory.

1.2 System Description

For operation a reader with antenna is required to send a command to the transponder and to receive its response (see figure 1). The command of the Reader can be either in addressed or non-addressed mode. The Transponder does not transmit data until the reader sends a request (Reader talks first principle).

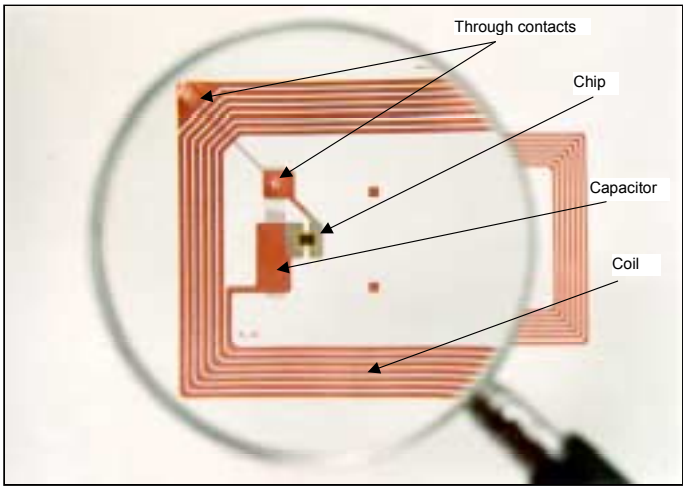
Figure 1 RFID System with reader, antenna and Tag-it HF Transponder



1.3 Product Description

The Tag-it HF Transponder consists of a resonance circuit assembled on a PET foil with a flip-chip mounted microchip. An aluminium antenna is used as inductor and 2 layers Aluminium on the top and bottom side of the foil function as capacitor. The two layers are contacted with through contacts (see figure 2). To protect the transponder from corrosive influences, the aluminium is covered with a gravure-resist ink.
For optimised performance the capacitor of Tag-it HF transponder is trimmed. The trim target includes frequency offset to compensate detuning that will occur after further integration.

Figure 2 Schematic structure of Tag-it HF Transponders



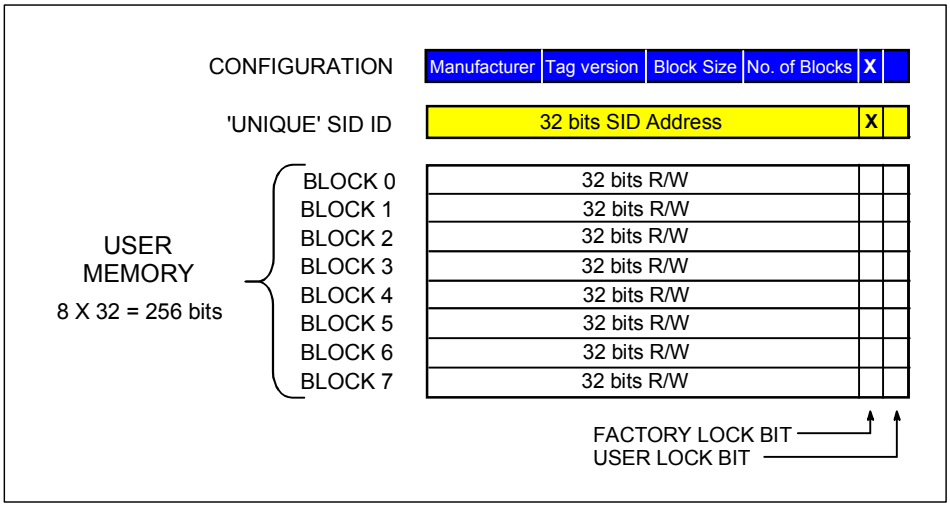
1.4 Functional Description

The Tag-it HF transponder is a low power, full duplex transponder for use with passive contactless identification transponder systems.
The transponder is designed to operate with a 13.56MHz carrier frequency. Down-Link communication (Reader to Transponder) is accomplished by pulse width modulation; Up-Link communication (Transponder to Reader) is implemented with sub-carrier modulation. Both, Up- and Down-Link are frame synchronized and CRC check sum secured. The device provides 256 Bit non-volatile user memory with block wise read/write and locking functionality. Each Tag-it HF transponder has a 'unique' address that is factory-programmed and 32 bits long (=2^{32} different addresses). You can address each transponder with this unique address or you can use the non-addressed mode. A mechanism to resolve collisions of a multiplicity of transponders ('Simultaneous IDentification - SID) is also implemented.
This special feature allows multiple transponders to be read simultaneously. The SID mechanism offers the capability to inventory in a very short time a large number of transponders by their unique address provided they are within the reader operating range.

1.5 Memory organization

User data is read and stored in a 256Bit non-volatile user memory that is organized in 8 blocks. Each block with 32 bits is user programmable and can be locked to protect data from modification. Once set, the lock bit cannot be reset.
The user memory is field programmable per block. Two levels of block locking are supported: Individual block locking by the user (U) or individual block locking of factory programmed data (F) during manufacturing. Block locking irreversibly protects the locked data from any further reprogramming. The 32 bit ROM code includes manufacturer code (7 Bit), chip version (9 Bit), block size (3 Bit), number of user memory blocks (8 Bit) and 3 bits reserved.

Figure 3 Memory organization of the Tag-it HF Transponder



1.6 Command Set

Table 1 Command Set for Tag-it HF Transponder

Request	Addressed/Non Addressed
Get_Version	✔/✔
Get_Block	✔/✔
Put_Block	✔/✔
Put&Lock_Block	✔/✔
Lock_Block	✔/✔
SID_Poll	- /✔
Quiet	✔/ ✔

✔: Implemented
- : Not applicable

1.7 Inlay Formats

To cover the special requirements of different applications, the Tag-it HF transponder Inlays are offered in four different shapes with metric and or imperial pitch.

Figure 4 Tag-it HF Transponder Inlay Rectangle-Large

Partnumber: RI-I02-110A (Metric pitch, 96mm)
Partnumber: RI-I12-110A (Imperial pitch, 4inch)

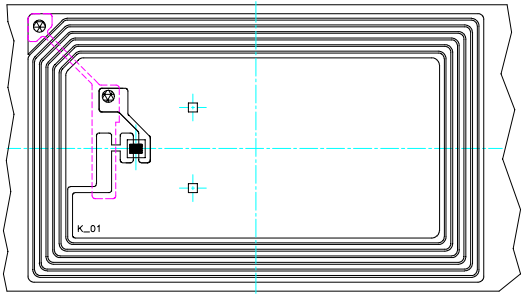


Figure 5 Tag-it HF Transponder Inlay Square

Partnumber: RI-I01-110A (Metric pitch, 48mm)
Partnumber: RI-I11-110A (Imperial pitch, 2inch)

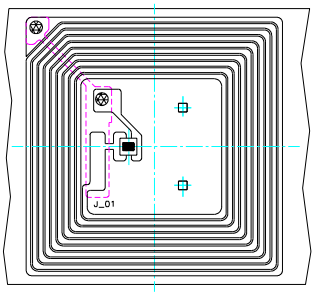


Figure 6 Tag-it HF Transponder Inlay Rectangle-Miniature

Partnumber: RI-I03-110A (Metric pitch, 48mm)

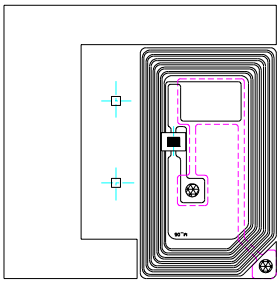
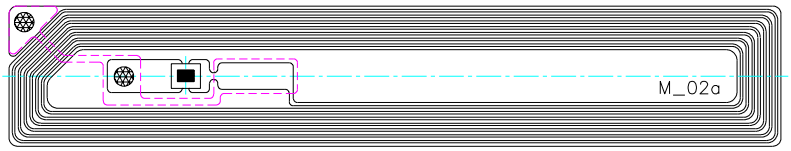


Figure 7 Tag-it HF Transponder Inlay Strip

Partnumber: RI-I14-110A (Imperial pitch, 4inch)



Chapter 2

Specification

This chapter provides the electrical and mechanical specifications of the Tag-it HF Transponder Inlays.

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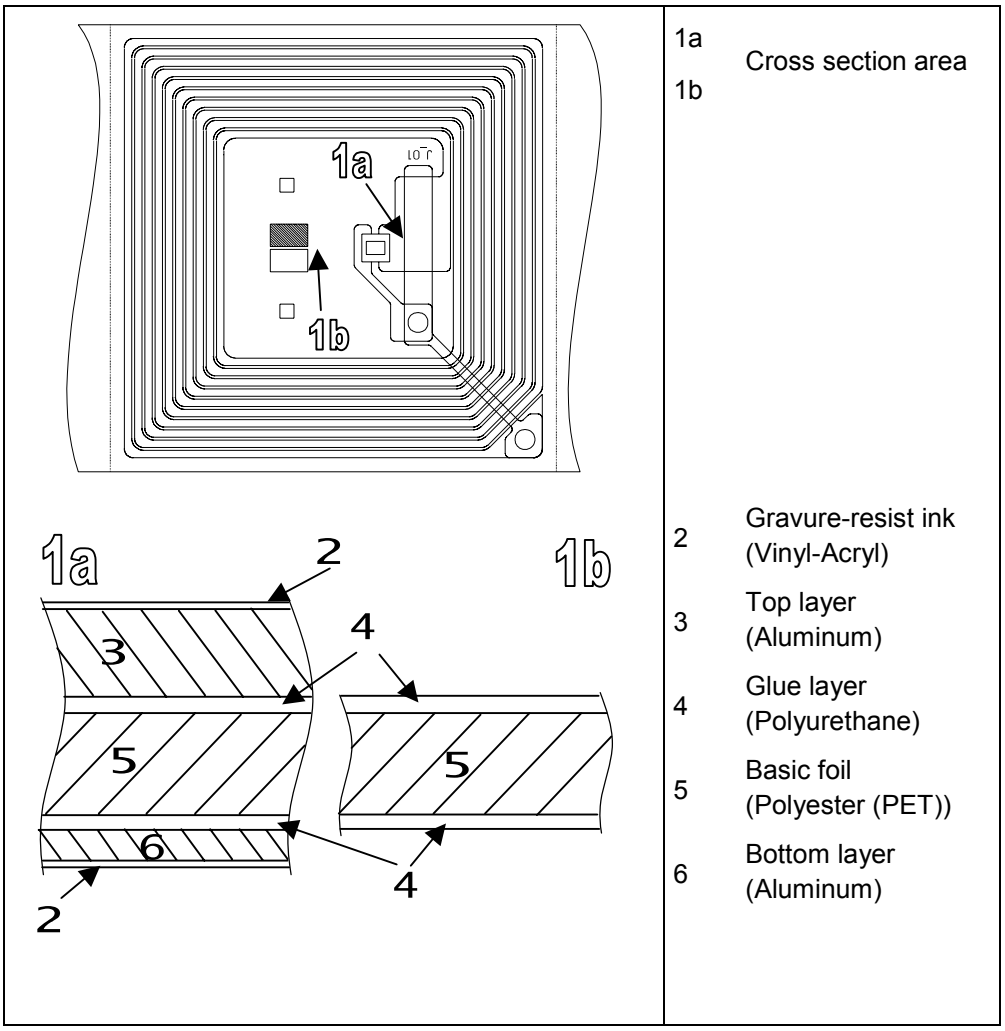
2.1 Material

The coil tracks, chip pads and upper capacitor plate are etched from the top layer aluminum, the bridge and the bottom capacitor plate are etched from the bottom layer aluminum.

- The surface of the foil is free of contamination by oil or grease (no fingerprints). However, there could be residuals of silicon dust, gravure resist on the substrate and dried residuals of PGMEA (= Propylene-Glycol-Monomethyl-Ether-Acetate).
- The wetability (surface energy) of the foil substrate is typically 42 mN/m

Figure 8 Cross Section Area of Tag-it HF Transponder Inlay



1a 1b	Cross section area
2	Gravure-resist ink (Vinyl-Acryl)
3	Top layer (Aluminum)
4	Glue layer (Polyurethane)
5	Basic foil (Polyester (PET))
6	Bottom layer (Aluminum)

2.2 Specification Summary

The following table applies to all Tag-it HF Transponder Inlay types.

Table 2 General Specification

Recommended Operating frequency	13.56 MHz
Factory programmed Read Only Number	32 bits
Memory (user programmable)	256 bits organized in 8 x 32-bit blocks
Typical programming cycles (at +25°C)	100,000
Data retention time (at +55°C)	> 10 years
Simultaneous Identification of Tags	Up to 50 tags per second (reader/antenna dependant)
RX modulation	Pulse-width coded, AM 100% modulation
Downlink data rates (Reader to Transponder)	6.2 kBaud (H-Bit), 9 kBaud (L-Bit)
TX frequencies	Manchester encoded, A = $f_c \pm 423.75$ kHz, B = $f_c \pm 484.29$ kHz Low bit: transition A to B. High bit: transition B to A
Uplink data rate (Transponder to Reader)	26.7 kBaud
Foil width	48 mm ± 0.5 mm (1.89 in ± 0.02 in)
Thickness	Chip: 0.355mm (~0.014 in) Antenna: 0.085mm (~0.0033 in)
Base material	Substrate: PET (Polyethylenetherephtalate) Antenna: Aluminum
Smallest bending radius allowed	18 mm (~0.71 in)
Operating temperature	-25°C to +70°C
Storage temperature (single inlay)	-40°C to +85°C (warpage may occur with increasing temperature)
Storage temperature (on reel)	-40°C to +40°C
Delivery	Single row tape wound on cardboard reel with 500 mm diameter Reel width: approx. 60 mm (~2.36 in); inside 50 mm (~1.97 in) Hub diameter: 76.2 mm (3 in)
Typical quantity per reel	5,000

The following tables consists device specific electrical parameters:

Table 3 Specification for RI-I01-110A, RI-I11-110A

Partnumber	**RI-I01-110A**	**RI-I11-110A**
Passive Resonance Frequency (at +25°C)	14.36 MHz ± 200kHz (includes frequency offset to compensate further integration into paper; drops down to operating frequency when exposed to activation field strength)	
Typical activation field strength read (at +25°C)	103dBµA/m	
Typical activation field strength write (at +25°C)	108 dBµA/m	
Antenna size	45 mm x 45 mm (~1.77 in x ~1.77 in)	
Foil pitch	48 mm +0.1mm/-0.4mm (~1.89 in)	50.8 mm +0.1mm/-0.4mm (2 in)

Table 4 Specification for RI-I02-110A, RI-I12-110A

Partnumber	RI-I02-110A	RI-I12-110A
Passive Resonance Frequency (at +25°C)	14.36 MHz ± 200kHz (includes frequency offset to compensate further integration into paper; drops down to operating frequency when exposed to activation field strength)	
Typical activation field strength read (at +25°C)	100dBµA/m	
Typical activation field strength write (at +25°C)	105 dBµA/m	
Antenna size	45 mm x 76 mm (~1.77 in x ~2.99 in)	
Foil pitch	96 mm +0.1mm/-0.4mm (~3.78 in)	101.6 mm +0.1mm/-0.4mm (4 in)

Table 5 Specification for RI-I03-110A

Partnumber	RI-I03-110A
Passive Resonance Frequency (at +25°C)	14.26 MHz ± 400kHz (includes frequency offset to compensate further integration into paper or PVC; drops down to operating frequency when exposed to activation field strength)
Typical activation field strength read (at +25°C)	112 dBµA/m (preliminary value)
Typical activation field strength write (at +25°C)	116 dBµA/m (preliminary value)
Antenna size	22.5 mm x 38 mm (~0.89 in x ~1.5 in)
Foil pitch	48 mm +0.1mm/-0.4mm (~1.89 in)

Table 6 Specification for RI-I14-110A

Partnumber	RI-I14-110A
Passive Resonance Frequency (at +25°C)	14.36 MHz ± 200kHz (includes frequency offset to compensate further integration into paper; drops down to operating frequency when exposed to activation field strength)
Typical activation field strength read (at +25°C)	108 dBµA/m (preliminary value)
Typical activation field strength write (at +25°C)	113 dBµA/m (preliminary value)
Antenna size	17 mm x 93 mm (~0.67 in x ~3.66 in)
Foil pitch	101.6 mm +0.1mm/-0.4mm (4 in)

2.3 Mechanical Drawings

Figure 9 Dimensions of RI-I02-110A, RI-I12-110A

Tag-it HF Transponder Inlay Large Rectangle (Metric Pitch)

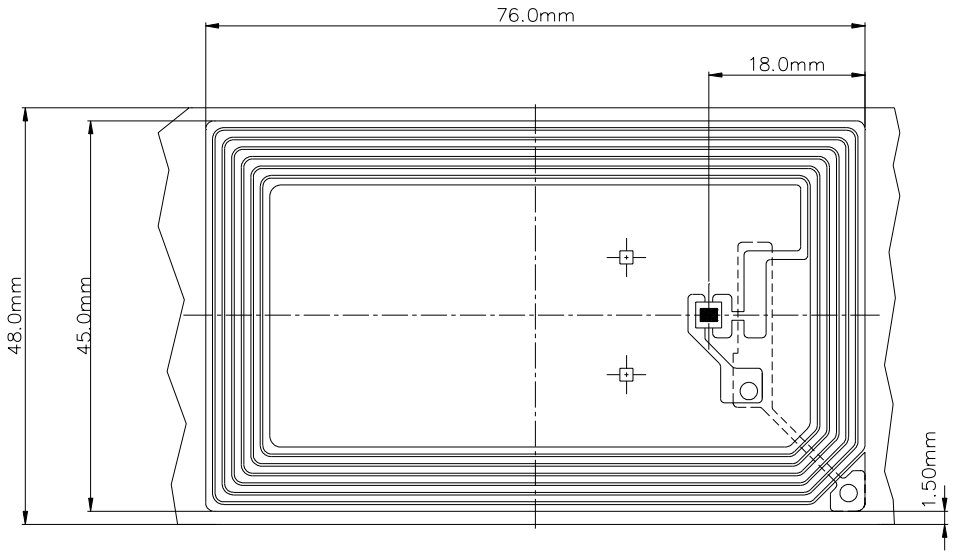


Figure 10 Dimensions of RI-I01-110A, RI-I11-110A

Tag-it HF Transponder Inlay Square

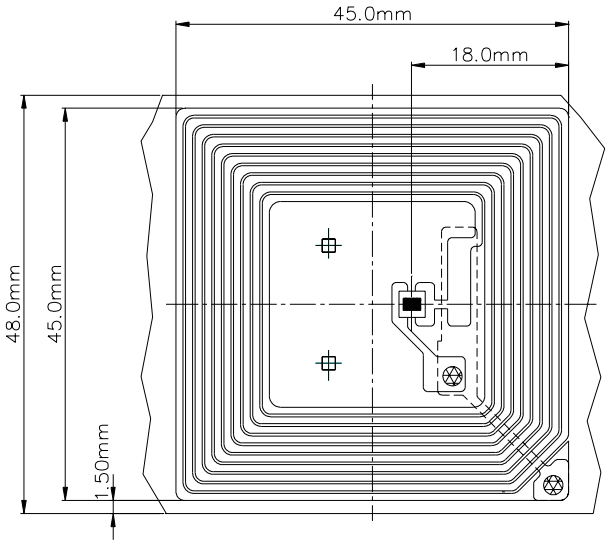


Figure 11 Dimensions of RI-I03-110A

Tag-it HF Transponder Inlay Rectangle-Miniature

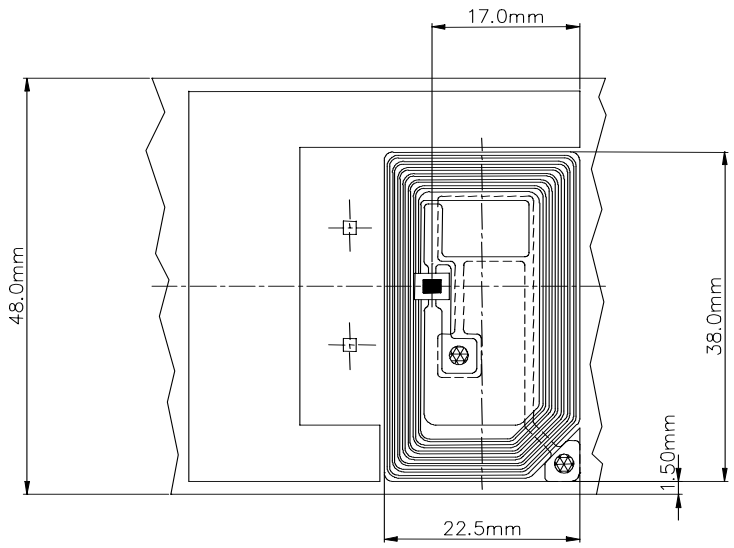
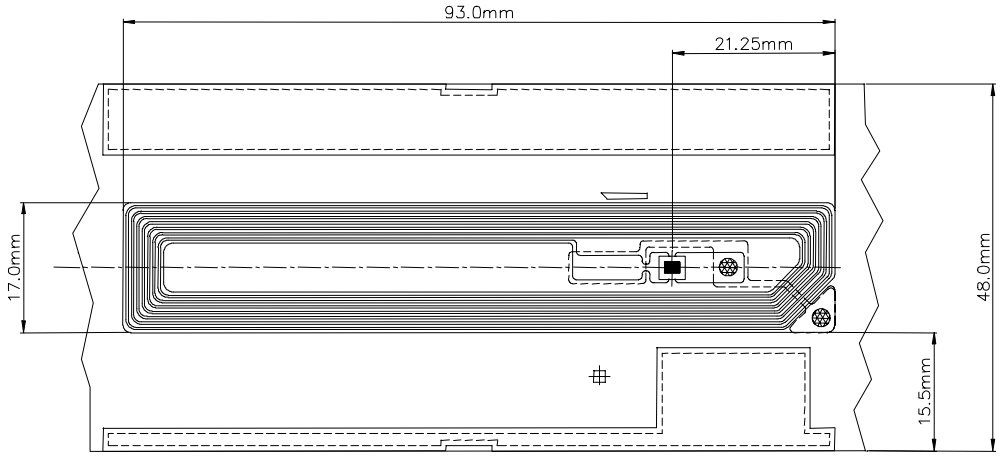


Figure 12 Dimensions of RI-I14-110A

Tag-it HF Transponder Inlay Strip



Chapter 3

Shipping, Packing & further Handling

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3.1 General

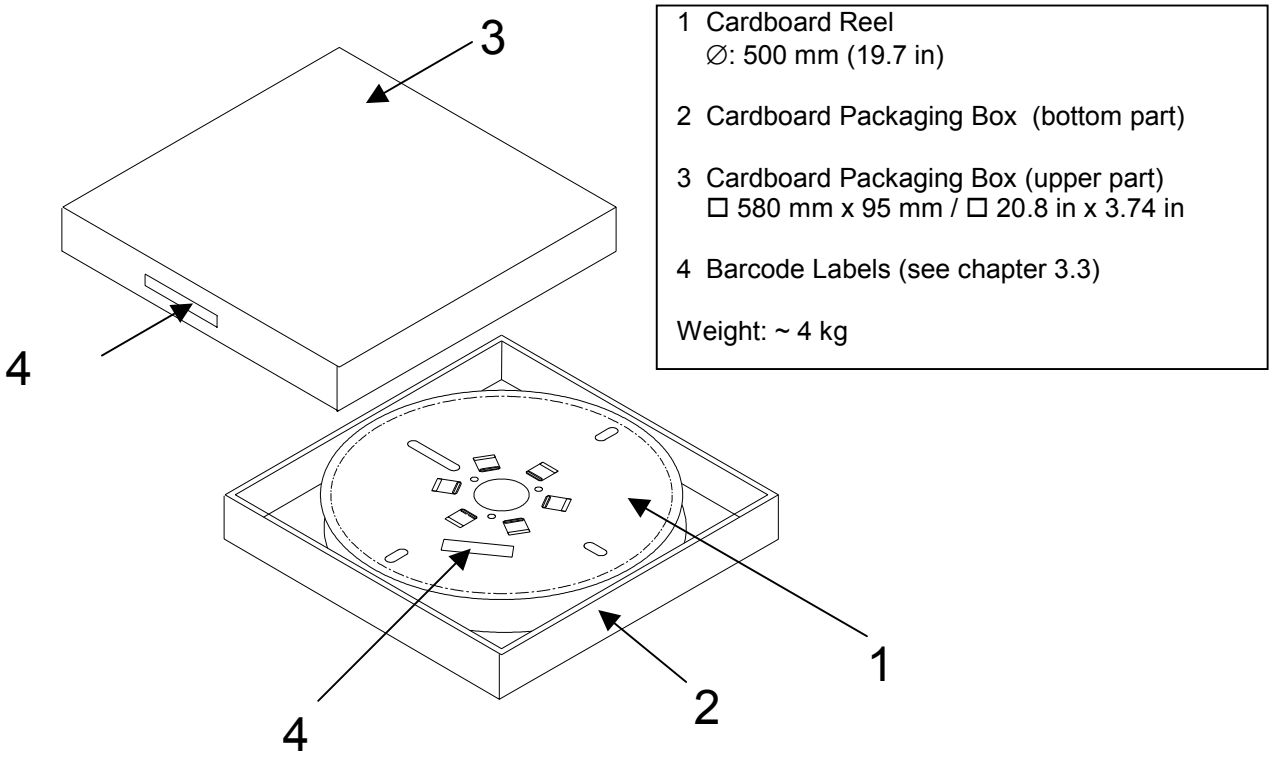
The Tag-it HF Transponder Inlays are delivered as single row tape wound on cardboard reels. The reels are packed separately in a packaging box.

Note:

Delivery may contain non-functional inlays.
These inlays are marked as described in chapter 3.5.

3.2 Packing

Figure 13 Packing



1 Cardboard Reel
∅: 500 mm (19.7 in)

2 Cardboard Packaging Box (bottom part)

3 Cardboard Packaging Box (upper part)
☐ 580 mm x 95 mm / ☐ 20.8 in x 3.74 in

4 Barcode Labels (see chapter 3.3)

Weight: ~ 4 kg

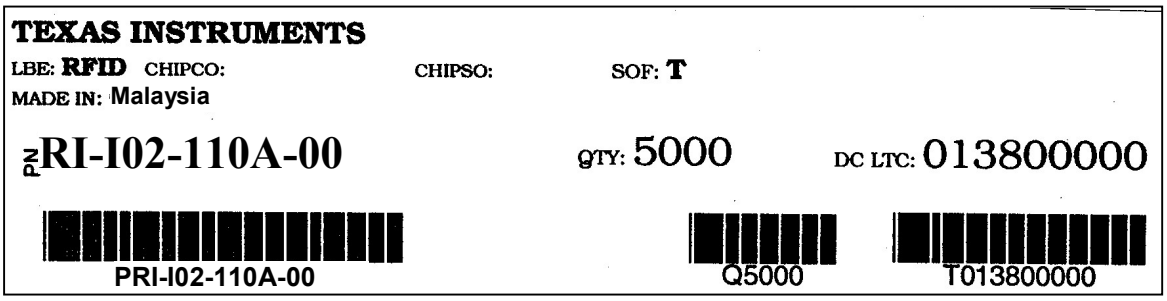
3.3 Barcode Label

The following figure shows the Barcode Label that is placed on the topside of the reel and on the front side of the upper part of its packing box.

Note:

The data provided below should only be viewed as guide values. A pack list will be enclosed with the delivery, which identifies the exact shipping details.

Figure 14 Barcode Label



PN	Part Number
QTY	Quantity of functional inlays per reel total quantity (incl. non-functional units) may exceed this number
DC LTC	Date code; Lot Number

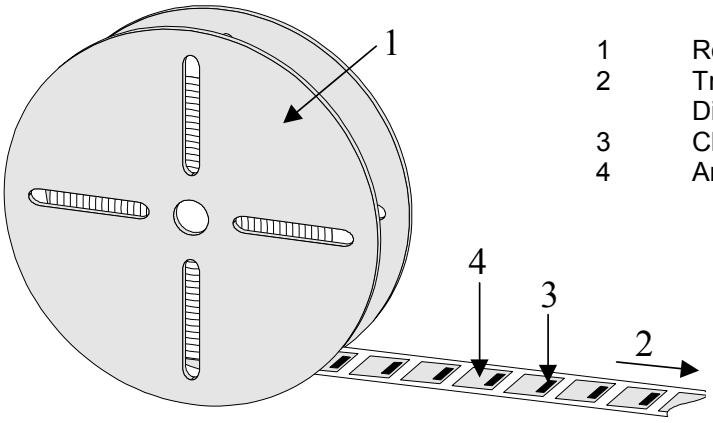
3.4 Unwind from transport reel

The reel is wound up with a tension of 3 N. Each tape has a chipless leader and a trailer that is approx. 3 m long.

Note:

Pullstrength during unwind needs to be controlled.

Figure 15 Transport (unwind) Direction



1 Reel
2 Transport (unwind) Direction
3 Chip/Capacitor area
4 Antenna

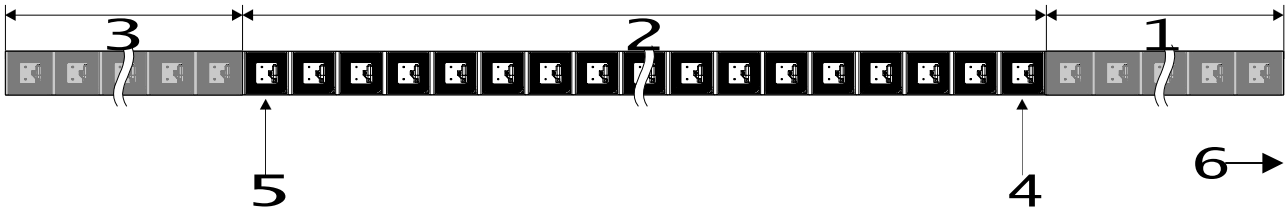
Figure 3 shows the transport reel and the leader of the Tag-it HF transponder inlays being pulled off the reel. Direction arrow 2 shows the direction in which the inlays should be unwound

CAUTION:

A high current density of an electrostatic discharge from the foil can damage the chip (IC). Therefore it is recommended to use ionizer or antistatic rollers in the manufacturing process. Any conductive parts in touch with Tag-it HF Inlays should have a high impedance discharge to ground. We recommend approx. 1MΩ to avoid ESD damage.

3.5 Chipless Leader and Trailer

Figure 16 Leader and Trailer configuration on the reel

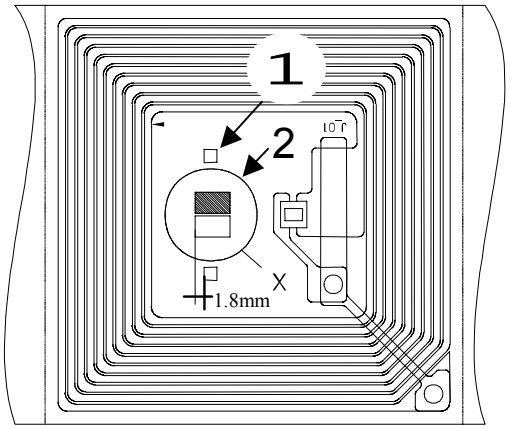


1	Chipless Leader	4	First functional Transponder Inlay
2	Transponder Inlays	5	Last functional Transponder Inlay
3	Chipless Trailer (Inlay not tested)	6	Transport direction

3.6 Marking of Inlays

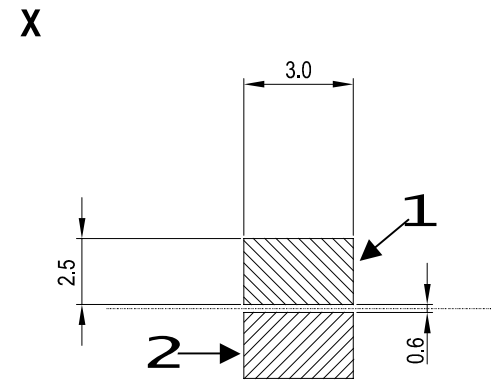
- The foil inlay has positioning marks for optical detection by a singulating or handling tool.
- Non-functional foil inlays are marked with a rectangular black mark near the center of the foil inlay.

Figure 17 Positioning, Function and Indication-Marks



1	Positioning Marks
2	Indication and Function Marks
X	Marking view (see figure 16)

Figure 18 Marking View



1	Indication mark (start section and end section)
2	Function mark (functional or non-functional)

In tested area the following combination for indication and function marks are possible:

Case 1:		Functional Inlay
Case 2:		Functional Inlay (first or last functional inlay on reel)
Case 3:		Non-functional Inlay (except first or last tested inlay)
Case 4:		Non-functional Inlay (if last inlay)

3.7 Static Pressure

Table 7 Static Pressure on the Chip Area

Static pressure on the chip area	max. 4 N/mm^2

CAUTION:

Higher pressure than that specified may result in chip cracks.

3.8 Tape Tension and Bending

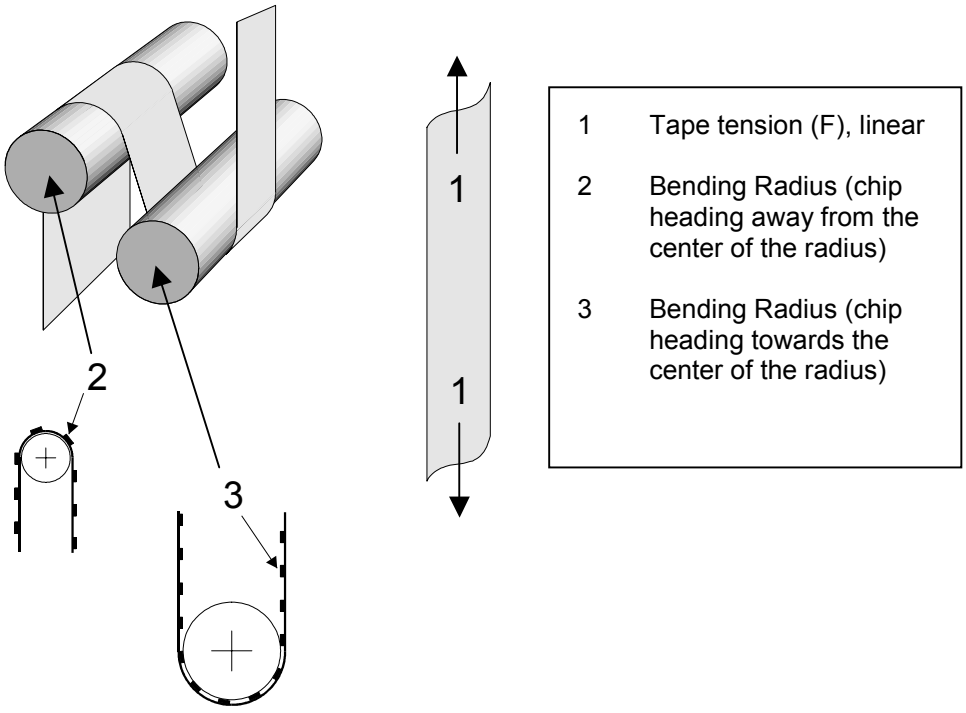
Table 8 Tape Tension and Bending

1	Tape tension (F), linear	max:	10 N
2	Bending Radius (chip heading away from the center of the radius)	min:	18 mm
3	Bending Radius (chip heading towards the center of the radius)	min:	18 mm

Note:

- The specification of the bending radius is based on a foil tape tension of 7.5 N.
- The Tag-it Transponder Inlay shall not be folded. Pullstrength during unwind needs to be controlled.

Figure 19 Tape Tension and Bending



Chapter 4

Regulatory, Safety and Warranty Notices

This chapter describes important safety precautions and safety regulations.

Topic Page

4.1 Regulatory, Safety and Warranty Notices

An RFID system comprises a RF transmission device, and is therefore subject to national and international regulations.

A system reading from or writing to these transponders may be operated only under an experimental license or final approval issued by the relevant approval authority. Before any such device or system can be marketed, an equipment authorization must be obtained form the relevant approval authority.

The Tag-it HF Transponder Inlay has been manufactured using state-of-the-art technology and in accordance with the recognized safety rules.

Observe precautions in operating instructions

- The most important condition for the safe use and fault-free operation of the Tag-it HF Transponder Inlay is the knowledge of the basic safety regulations.
- All persons who operate with the Tag-it HF Transponder Inlay must observe the packaging guideline and particularly the safety precautions.
- In addition, basic rules and regulations for accident prevention applicable to the operating site must also be considered.

4.2 Warranty and Liability

The "General Conditions of Sale and Delivery" of Texas Instruments Incorporated or a TI subsidiary applies. Warranty and liability claims for defect products, injuries to persons and property damages are void if they are the result of one or more of the following causes:

- improper use of the transponders
- unauthorized assembly, operation and maintenance of the transponders
- operation of the transponders with defective and/or non-functioning safety and protective equipment
- failure to observe the instructions during transport, storage, assembly, operation, maintenance and setting up of the transponders
- unauthorized changes to the transponders
- insufficient monitoring of the transponders' operation or environmental conditions
- repairs
- catastrophes caused by foreign bodies and acts of God.

CAUTION:

Tag-it HF Transponder Inlays are 100% thoroughly tested. It is the responsibility of TI´s customer to evaluate their packaging process for compatibility with the Tag-it HF Transponder Inlay properties and to ensure through appropriate process controls that determined machine and material parameter are met on an ongoing basis.
TI does not accept warranty claims for material that has already undergone packaging or conversion process.

4.3 Hazards from Electrostatic Discharge ESD

During unwinding the foil and the separator tape are charged electrostatically (depending on the unwinding speed and the tensile stress). For the proper operation of the machine it is necessary to de-ionise the foil to remove the electrostatic charge.

WARNING:

IN ADDITION TO THE HEALTH HAZARD DEPENDENT ON THE SENSITIVITY OF THE RESPECTIVE PERSON, ELECTRONIC DEVICES CAN ALSO BE DESTROYED BY ELECTROSTATIC ENERGY.

4.4 Danger of Cutting Injuries

Take care when unwinding the foil. The greater the unwinding speed and the tensile stress, the greater the risk of receiving a cut when the edge of the foil is touched.

4.5 Thermal Effects

Temperatures > +85 °C on the foil inlay during the packaging process may result in a significant and permanent material deformation and a possible change of color of the foil inlays, as well as a change in the electrical characteristics.

4.6 Handling

The settings for foil unwinding and for the attendant forces must be in accordance to the information in Section 'Tape Tension and Bending' of Chapter 3.

APPENDIX A

Terms & Abbreviations

The list of the abbreviations and terms used in various TI-RFID manuals can now be found in a separate manual:

TI-RFID Product Manuals - Terms & Abbreviations

Document number 11-03-21-002