Tag-it™ HF-I Pro Transponder Inlays

Reference Guide

Literature Number: SCBU009B
December 2005–Revised September 2011

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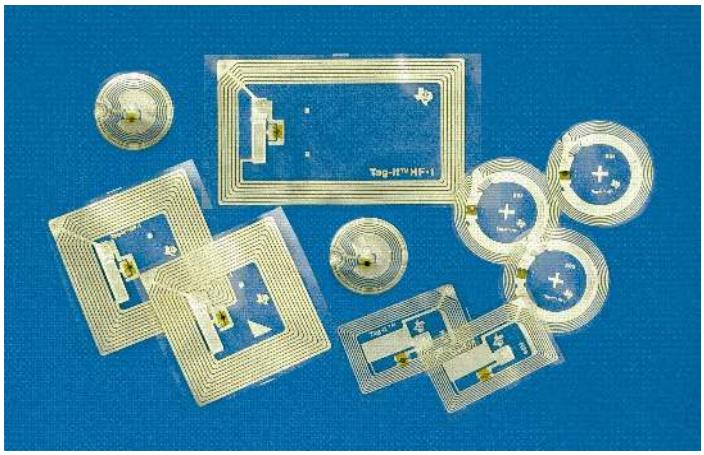
Read This First

Edition Two – September 2011

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



About This Guide

This reference guide for the Tag-it HF-I Pro Transponder 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 that must be met or a procedure that must be followed, which if not heeded, could cause permanent damage to the equipment or software.

NOTE: Indicates conditions that must be met or procedures that must be followed, to ensure proper functioning of any equipment or software.

Information:
Indicates information that makes usage of the equipment or software easier.

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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

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Introduction

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

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1.1 General

The Tag-it HF-I Pro Transponder Inlays are part of TI's 13.56-MHz product family based on the ISO/IEC 15693 standard for contactless integrated circuit cards (vicinity cards) and the ISO/IEC 18000-3 standard for item management. The Tag-it HF-I Pro Transponder Inlays, available in various inlay shapes, also form the basis of consumable smart labels for use in markets requiring quick and accurate identification of items, such as:

- Asset tagging
- Electronic ticketing
- Anti-counterfeit prevention
- Building access badges

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 nonvolatile 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, it can only be changed by the password-protected Write command.

For example, information about delivery checkpoints and timing, place of origin/destination, pallet assignments, inventory numbers, and even transportation routes can be coded into the transponder.

Multiple Tag-it HF-I Pro Transponder Inlays, which appear in the Reader RF field, can be identified, read from, and written to by using the unique identifier (UID), which is programmed and locked at the factory and cannot be changed.

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 1-1). 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).

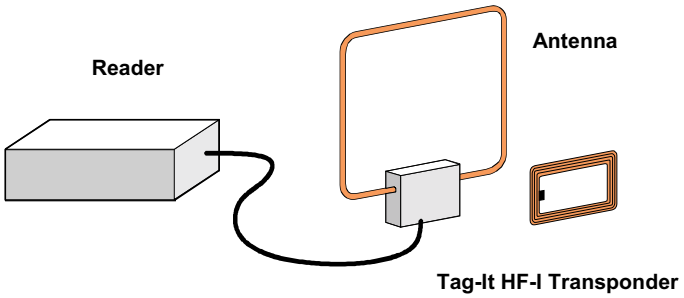

Figure 1-1. RFID System With Reader, Antenna, and Tag-it™ HF-I Transponder

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1.3 Product Description

The Tag-it HF-I Pro Transponder is compliant to the ISO/IEC 15693-2,-3 and ISO/IEC 180000-3 standards. It consists of a resonance circuit assembled on a PET foil with a flip-chip mounted microchip. An aluminum antenna is used as inductor, and two layers of aluminum on the top and bottom side of the foil function as a capacitor. The two layers are contacted with through contacts (see Figure 1-2). TI uses this capacitor to individually tune each device to a target resonance frequency. This compensates for any material and process tolerances and, therefore, ensures optimal performance of every single transponder inlay. The trim target includes frequency offset to compensate detuning that occurs after further integration into different materials, such as paper or PVC.

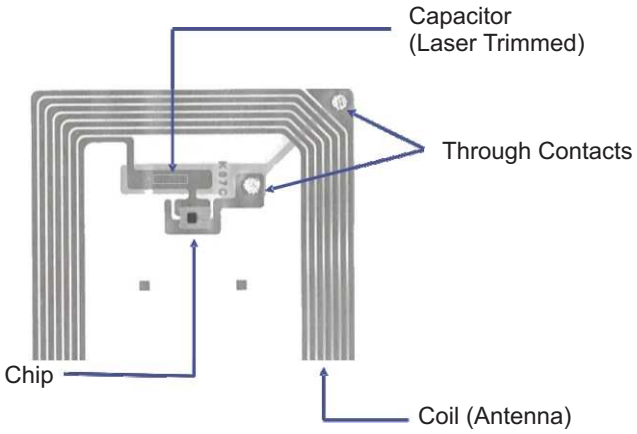

Figure 1-2. Schematic Structure of Tag-it HF-I Pro Transponders

1.4 Functional Description

The Tag-it HF-I Pro Transponder is a low-power, full-duplex transponder for use with passive contactless identification transponder systems.

The Transponder is designed to operate with a 13.56-MHz carrier frequency. The ISO standards define, for some communication parameters, several modes in order to meet different international radio regulations and different application requirements. Therefore, communication between the Reader and the Transponder (Down-Link communication) takes place using an ASK modulation index between 10% and 30% or 100% and data coding (pulse position modulation), 1 out of 4 or 1 out of 256.

According to ISO/IEC 15693-2 and ISO/IEC18000-3, Up-Link communication (Transponder to Reader) can be accomplished with one subcarrier (ASK modulation) or with two subcarriers (FSK modulation). Both modes (ASK and FSK) can operate with either high or low data rate. **The Transponder will answer in the mode it was interrogated from the Reader and supports all communication parameter combinations.** Up- and Down-Link are frame synchronized and CRC checksum secured.

Each Tag-it HF-I Pro Transponder has a unique address (UID) stored in two blocks that are factory programmed and 64 bits long (=2^{64} different addresses). This can be used for addressing each transponder uniquely and individually for a one-to-one exchange between the Reader and the Transponder. A mechanism to resolve collisions of a multiplicity of transponders (Anticollision) is also implemented. This special feature allows multiple transponders to be read simultaneously and 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.

Also, the application family identifier (AFI), which is optional in the ISO/IEC 15693, is supported by the Tag-it HF-I Pro Transponder.

For more details about the communication between Reader and Transponder, see ISO/IEC 15693 and the Tag-it HF-I Pro Extended Command Specification.

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1.5 Memory Organization

User data is read and stored in a 256-bit nonvolatile user memory that is organized in eight blocks. Each block with 32 bits is user programmable and can be locked individually to protect data from modification. Once set, the lock bit cannot be reset. The user memory is field programmable per block. User-locked blocks can be reprogrammed by use of the password-protected write command.

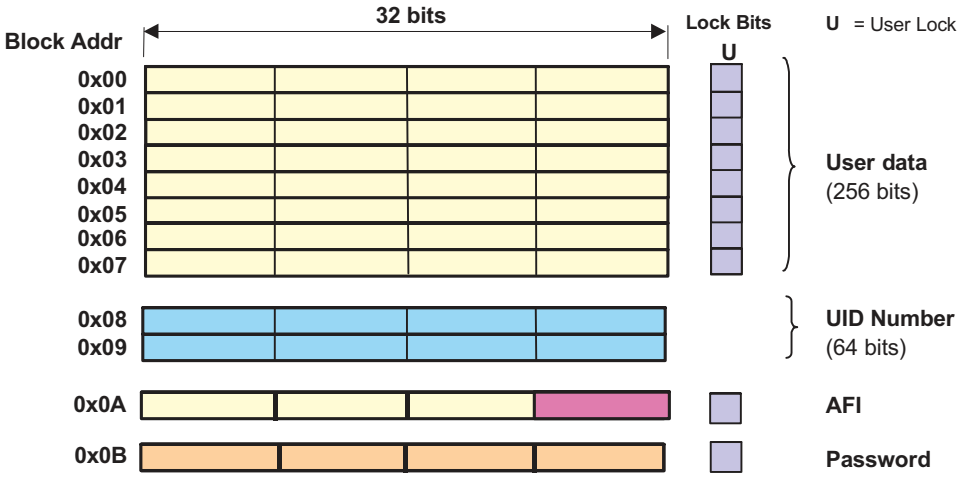

Figure 1-3. Memory Organization of the Tag-it HF-I Pro Transponder

1.6 Command Set

Table 1-1. Command Set For Tag-it HF-I Pro Transponder

		Request Mode [1]				
REQUEST	**REQUEST CODE**	**INVENTORY**	**ADDRESSED**	**NON-ADDRESSED**	**AFI**	**OPT FLAG**
ISO 15693 Mandatory and Optional Commands						
Inventory	0x01	✓	–	–	✓	0
Stay Quiet	0x02	–	✓	–	–	0
Read_Single_Block	0x20	–	✓	✓	–	1
Write_Single_Block	0x21	–	✓	✓	–	1
Lock_Block	0x22	–	✓	✓	–	1
TI Custom Commands						
Kill	0xA4	–	✓	–	–	1
WriteSingleBlockPwd	0xA5	–	✓	–	–	1

(1) ✓: Implemented
–: Not applicable
0/1: Option flag needed

NOTE: The Option flag (bit 7) of the ISO 15693 defined Request flags must be set to 1 for all Write and Lock commands to respond properly.

For reliable programming, we recommend a programming time ≥10 ms before the Reader sends the end of frame (EOF) to request the response from the Transponder.

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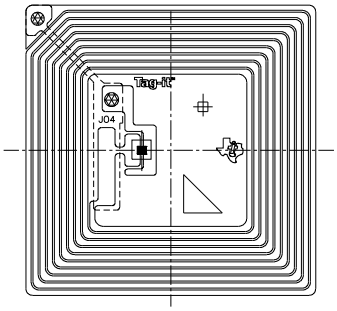
1.7 Inlay Formats and Part Numbers

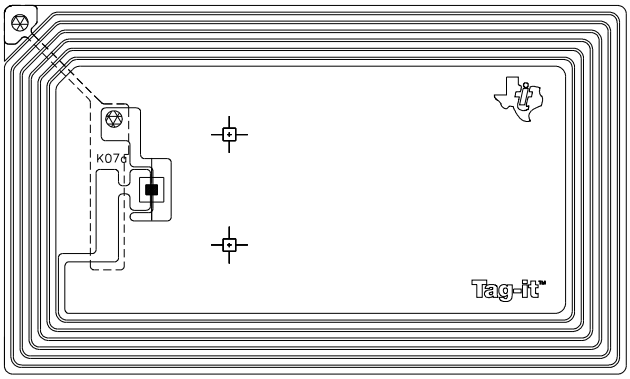
To cover the specific requirements of different applications, the Tag-it HF-I Pro Transponder Inlays are offered in different shapes, with frequency offset options for further integration into paper or PVC lamination.



Part number: RI-I11-114A-S1 (frequency offset for further integration into paper)

Part number: RI-I11-114B-S1 (frequency offset for PVC lamination)

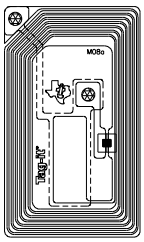
Figure 1-4. Tag-it HF-I Pro Transponder Inlay Square



Part number: RI-I02-114A-S1 (frequency offset for further integration into paper)

Part number: RI-I02-114B-S1 (frequency offset for PVC lamination)

Figure 1-5. Tag-it HF-I Pro Transponder Inlay Rectangle – Large



Part number: RI-I03-114A-S1 (frequency offset for further integration into paper or PVC lamination)

Figure 1-6. Tag-it HF-I Pro Transponder Inlay Rectangle – Miniature

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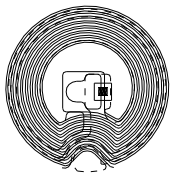
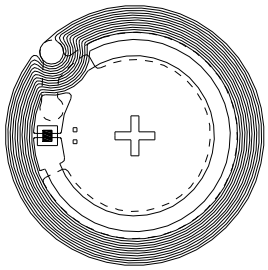


Part number: RI-I16-114A-S1 (frequency offset for further integration into paper or PVC lamination)

Figure 1-7. Tag-it HF-I Pro Transponder Inlay – 24.2 mm Circular



Part number: RI-I17-114A-S1 (frequency offset for further integration into paper or PVC lamination

Figure 1-8. Tag-it HF-I Pro Transponder Inlay – CD (32.5 mm Circular)

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Specification

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

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2.1 Material Composition

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.

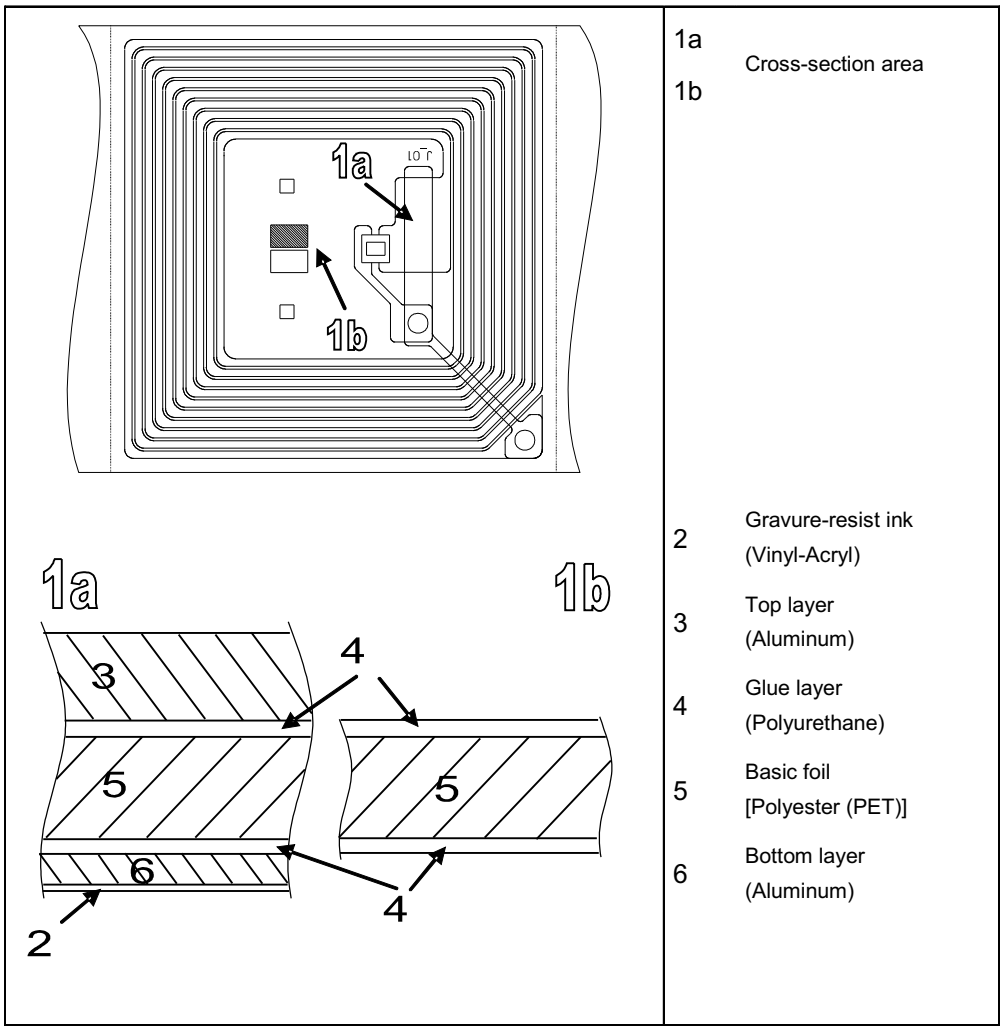

Figure 2-1. Cross-Section Area of Tag-it HF-I Pro Transponder Inlay

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2.2 Specification Summary

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

Table 2-1. General Specification

Recommended operating frequency	13.56 MHz
Factory programmed read-only number	64 bits
Memory (user programmable)	2k bits organized in 64-bit × 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)
Foil width	48 mm ± 0.5 mm (1.89 in ± 0.02 in)
Thickness	Chip area: 0.34 mm ±0.02 Antenna area (Al both sides): 0.085 mm ±0.01 Antenna area (Al one side): 0.075 mm ±0.008
Base material	Substrate: PET (Polyethylenetherephtalate) Antenna: aluminum
Smallest bending radius allowed	18 mm (~0.71 in)
Tape tension (F), linear	Maximum 10 N
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
ESD immunity	Minimum 3.5 kV (Human-Body Model) Minimum 200 V (Machine Model)
Delivery	Single-row tape wound on cardboard reel with 500-mm diameter Reel outer width: approximately 60 mm (~2.36 in) Reel inner width: approximately 50 mm (~1.97 in) Hub diameter: 76.2 mm (3 in)
Typical quantity of good units per reel	5,000

NOTE: For highest possible read-out coverage, operate Readers at a modulation depth of 20% or higher.

The following tables consist of device-specific parameters:

Table 2-2. Specification for RI-I11-114A-S1, RI-I11-114B-S1

	PART NUMBER	
	RI-I11-114A-S1	**RI-I11-114B-S1**
Passive resonance frequency (at 25°C)	13.86 MHz ± 200 kHz (includes frequency offset to compensate further integration into paper)	14.4 MHz ± 200 kHz (includes frequency offset to compensate PVC lamination)
Typical required activation field strength read (at 25°C)	98 dBµA/m(1)	98 dBµA/m(2)
Maximum required activation field strength read (at 25°C)	101 dBµA/m(1)	101 dBµA/m(2)
Typical required activation field strength write (at 25°C)	101 dBµA/m(1)	101 dBµA/m(2)
Antenna size	45 mm × 45 mm (~1.77 in × ~1.77 in)	
Foil pitch	48 mm + 0.1 mm / – 0.4 mm (~1.89 in)	

(1) After integration into paper
(2) After PVC lamination

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Table 2-3. Specification for RI-I02-114A-S1, RI-I02-114B-S1

	PART NUMBER	
	RI-I02-114A-S1	RI-I02-114B-S1
Passive resonance frequency (at 25°C)	13.86 MHz ± 200 kHz (includes frequency offset to compensate further integration into paper)	14.4 MHz ± 200 kHz (includes frequency offset to compensate PVC lamination)
Typical required activation field strength read (at 25°C)	94 dBµA/m(1)	94 dBµA/m(2)
Maximum required activation field strength read (at 25°C)	97 dBµA/m(1)	97 dBµA/m(2)
Typical required activation field strength write (at 25°C)	97 dBµA/m(1)	97 dBµA/m(2)
Antenna size	45 mm × 76 mm (~1.77 in × ~2.99 in)	
Foil pitch	96 mm + 0.1 mm / – 0.4 mm (~3.78 in)	

(1) After integration into paper
(2) After PVC lamination

Table 2-4. Specification for RI-I03-114A-S1

	PART NUMBER
	RI-I03-114A-S1
Passive resonance frequency (at 25°C)	13.86 MHz ± 200 kHz (includes frequency offset to compensate further integration into paper or PVC lamination)
Typical required activation field strength read (at 25°C)	107 dBµA/m(1)
Maximum required activation field strength read (at 25°C)	109 dBµA/m(1)
Typical required activation field strength write (at 25°C)	111 dBµA/m(1)
Antenna size	22.5 mm × 38 mm (~0.89 in × ~1.5 in)
Foil pitch	48 mm + 0.1 mm / – 0.4 mm (~1.89 in)

(1) After integration into paper or PVC lamination

Table 2-5. Specification for RI-I16-114A-S1

	PART NUMBER
	RI-I16-114A-S1
Passive resonance frequency (at 25°C)	13.70 MHz ± 400 kHz (includes frequency offset to compensate further integration into paper or PVC lamination)
Typical required activation field strength read (at 25°C)	113 dBµA/m(1)
Maximum required activation field strength read (at 25°C)	116 dBµA/m(1)
Typical required activation field strength write (at 25°C)	116 dBµA/m(1)
Antenna size	∅ 24.2 mm + 0.1 mm / – 0.2 mm (~0.95 in)
Foil pitch	50.8 mm + 0.1 mm / – 0.3 mm (2 in)

(1) After integration into paper or PVC lamination

Table 2-6. Specification for RI-I17-114A-S1

	PART NUMBER
	RI-I17-114A-S1
Passive resonance frequency (at 25°C)	13.80 MHz ± 400 kHz (includes frequency offset to compensate further integration into paper or PVC lamination)
Typical required activation field strength read (at 25°C)	110 dBµA/m(1)
Maximum required activation field strength read (at 25°C)	113 dBµA/m(1)
Typical required activation field strength write (at 25°C)	113 dBµA/m(1)
Antenna size	Outer diameter: ∅ 32.5 mm + 0.1 mm / – 0.2 mm (~1.28 in) Inner diameter: min. ∅ 18 mm (~0.7 in)
Foil pitch	50.8 mm + 0.1 mm / – 0.3 mm (2 in)

(1) After integration into paper or PVC lamination

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2.3 Mechanical Drawings

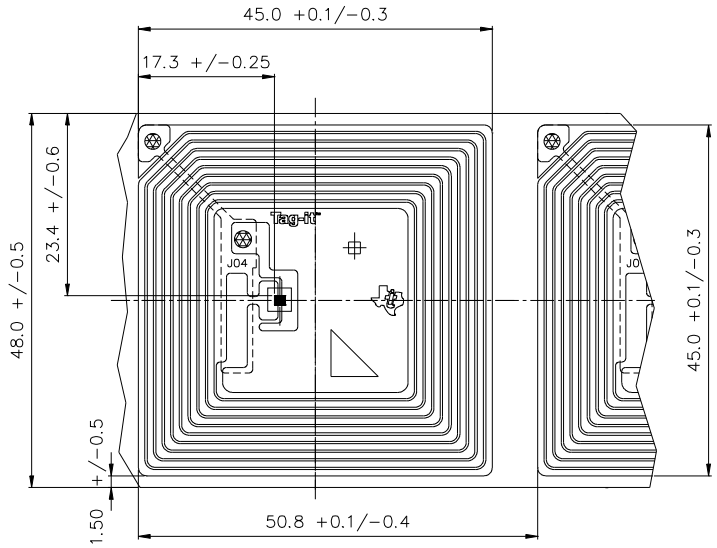

Figure 2-2. Dimensions of Tag-it HF-I Pro Transponder Inlay Square (RI-I11-114A-S1, RI-I11-114B-S1)

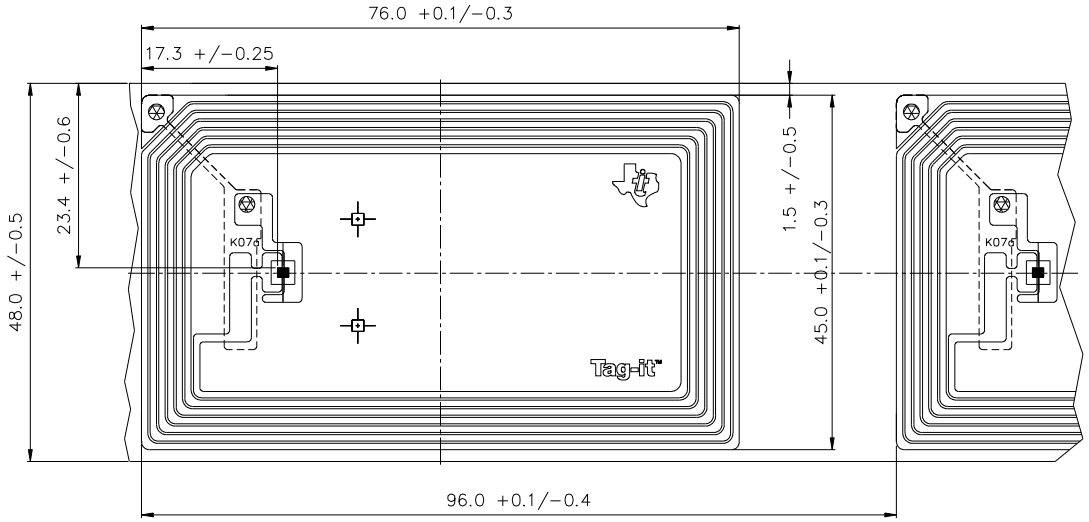

Figure 2-3. Dimensions of Tag-it HF-I Pro Transponder Inlay Rectangle – Large (RI-I02-114A-S1, RI-I02-114B-S1)

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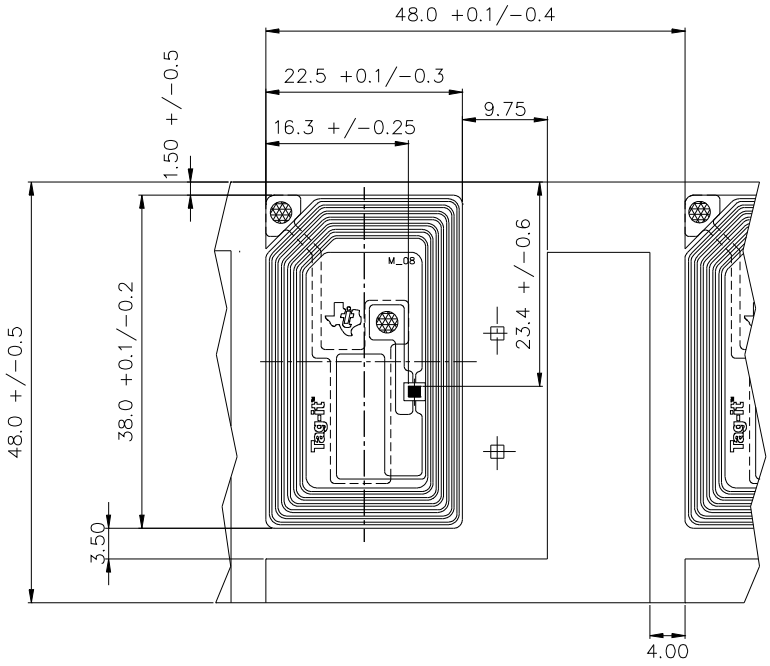

Figure 2-4. Dimensions of Tag-it HF-I Pro Transponder Inlay Rectangle – Miniature (RI-I03-114A-S1)

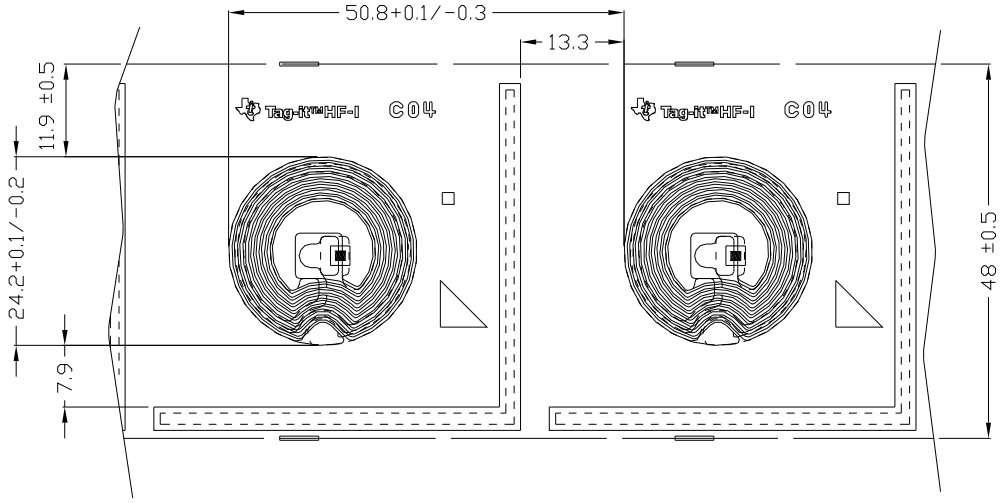

Figure 2-5. Dimensions of Tag-it HF-I Pro Transponder Inlay – 24.2 mm Circular (RI-I16-114A-S1)

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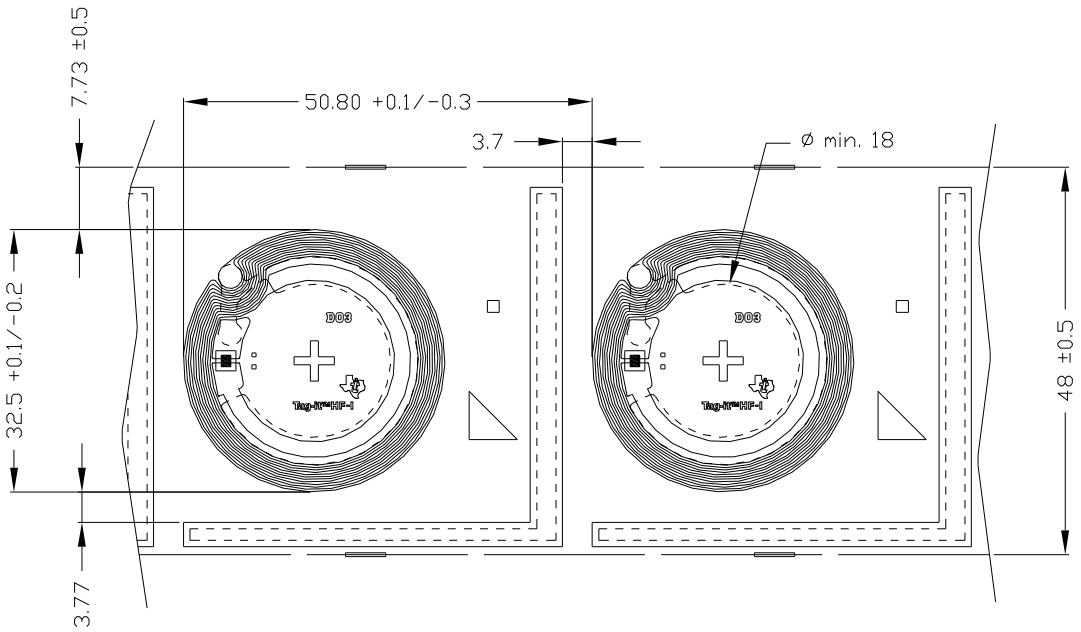

Figure 2-6. Dimensions of Tag-it HF-I Pro Transponder Inlay – CD (32.5 mm Circular) (RI-I17-114A-S1)

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Shipping, Packing, and Further Handling

Topic **Page**

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3.1 General

The Tag-it HF-I Pro Transponder Inlays are delivered as single-row tape wound on cardboard reels. Each is packed separately in a packing box.

NOTE: Delivery may contain nonfunctional inlays. These inlays are marked as described in Chapter 3.5.

3.2 Packing

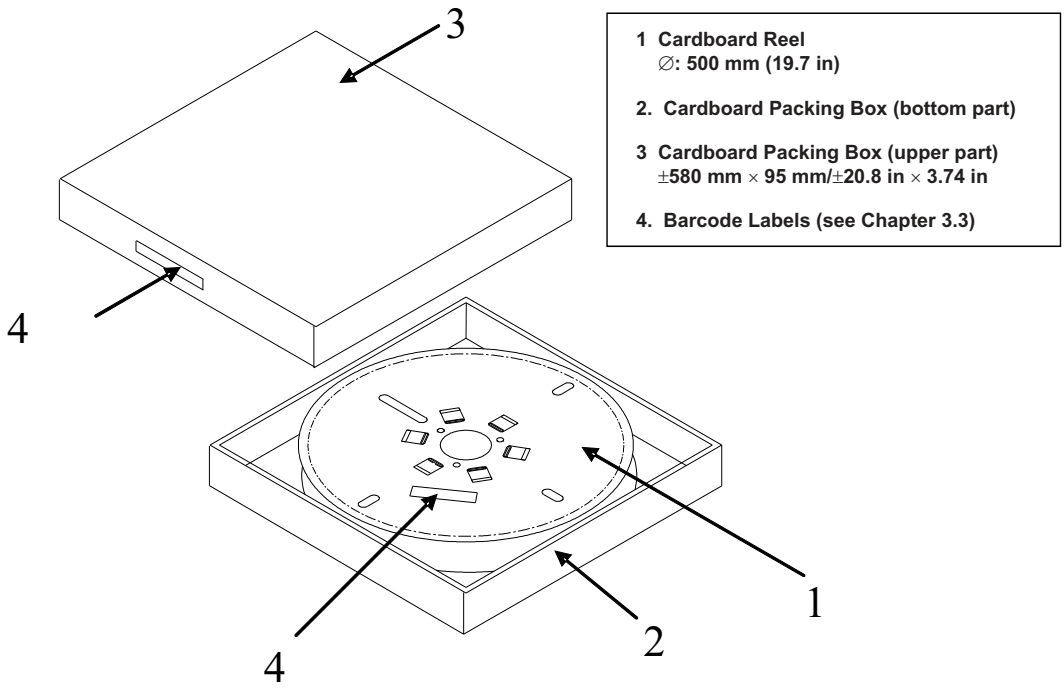

Figure 3-1. Packing

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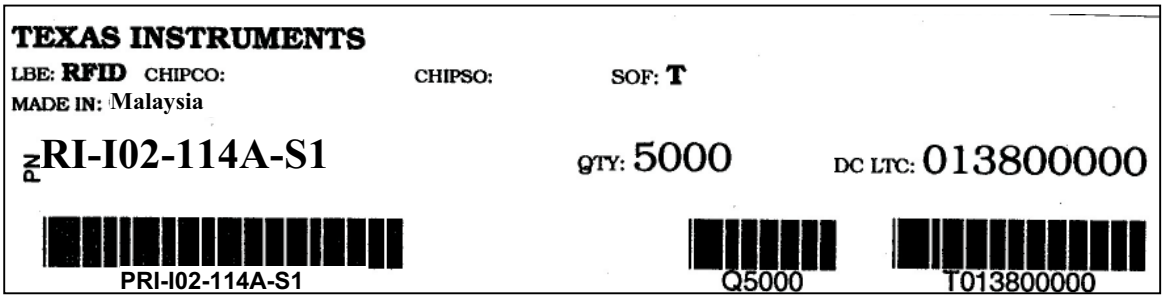
3.3 Barcode Label

Figure 3-2 shows the barcode label that is placed on the top side of the reel and on the front side of the upper part of its packing box.

NOTE: The following data is an example and should only be viewed as guide values. A packlist will be enclosed with the delivery, which identifies the exact shipping details.



PN	Part Number
QTY	Quantity of functional inlays per reel total quantity (including nonfunctional units) may exceed this number
DC LTC	Datecode; Lot Number

Figure 3-2. Barcode Label

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 approximately 3 m long.

NOTE: Pull strength during unwind needs to be controlled.

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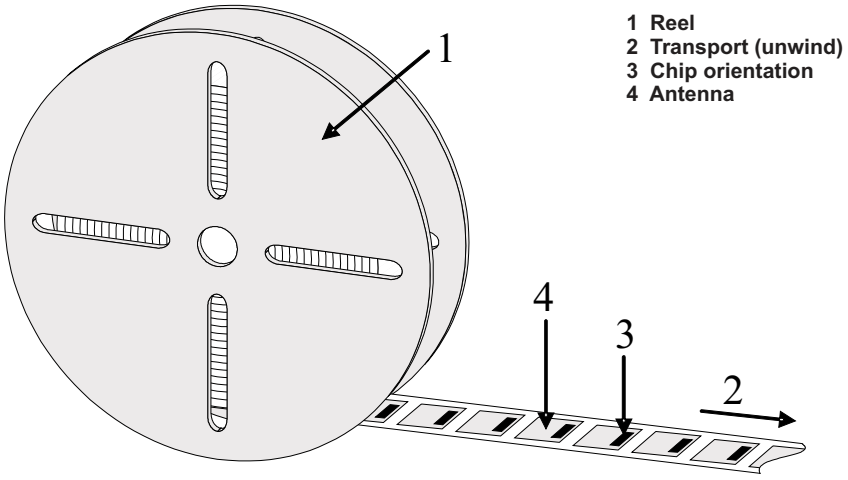


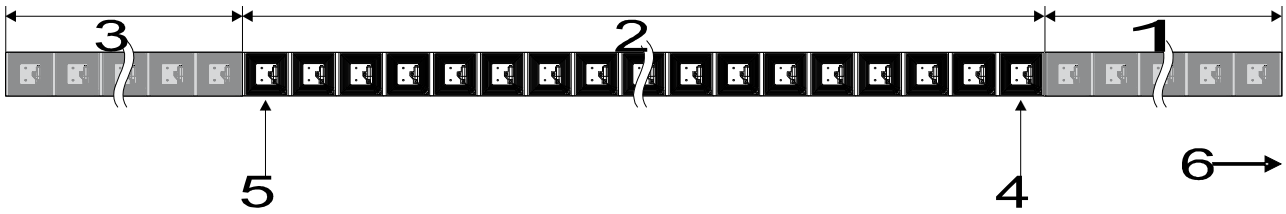
Figure 3-3. Transport (Unwind) Direction

Figure 3-3 shows the transport reel and the leader of the Tag-it HF-I Plus Transponder Inlays being pulled off the reel.

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-I Pro Inlays should have a high-impedance discharge to ground. We recommend approximately 1 MΩ to avoid ESD damage.

3.5 Chipless Leader and Trailer



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

Figure 3-4. Leader and Trailer Configuration on the Reel

3.6 Marking of Inlays

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

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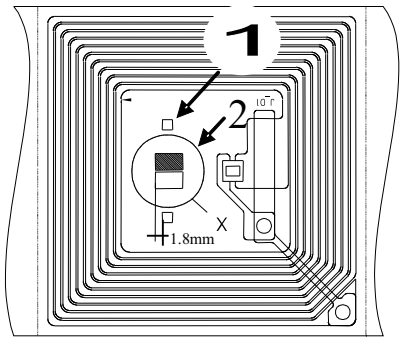
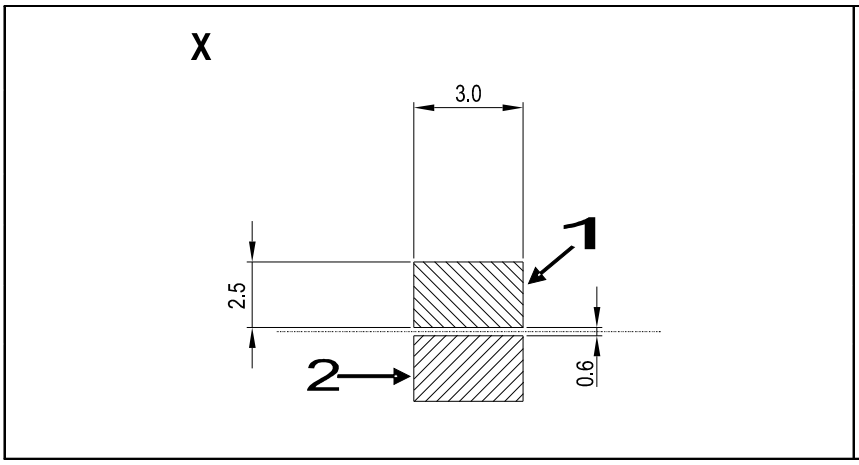


1 Positioning Marks
2 Indication and Function Marks
X Marking View (see Figure 3-6)

Figure 3-5. Positioning, Function, and Indication Marks



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

Figure 3-6. Marking View

In tested area (not trailer/leader section), the following combination for indication and function marks is possible:

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

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3.7 Static Pressure

Table 3-1. Static Pressure on the Chip Area

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

CAUTION

Higher pressure than that specified may result in chip cracks.

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3.8 Tape Tension and Bending

Table 3-2. Tape Tension and Bending

1	Tape tension (F), linear	MAX: 10 N
2	Bending radius (chip heading away from the center of the radius at 7.5-N foil tape tension)	MIN: 18 mm
3	Bending radius (chip heading towards the center of the radius at 7.5-N foil tape tension)	MIN: 18 mm

NOTE: The Tag-it HF-I Pro Transponder Inlay shall not be folded. Pull strength during unwind needs to be controlled.

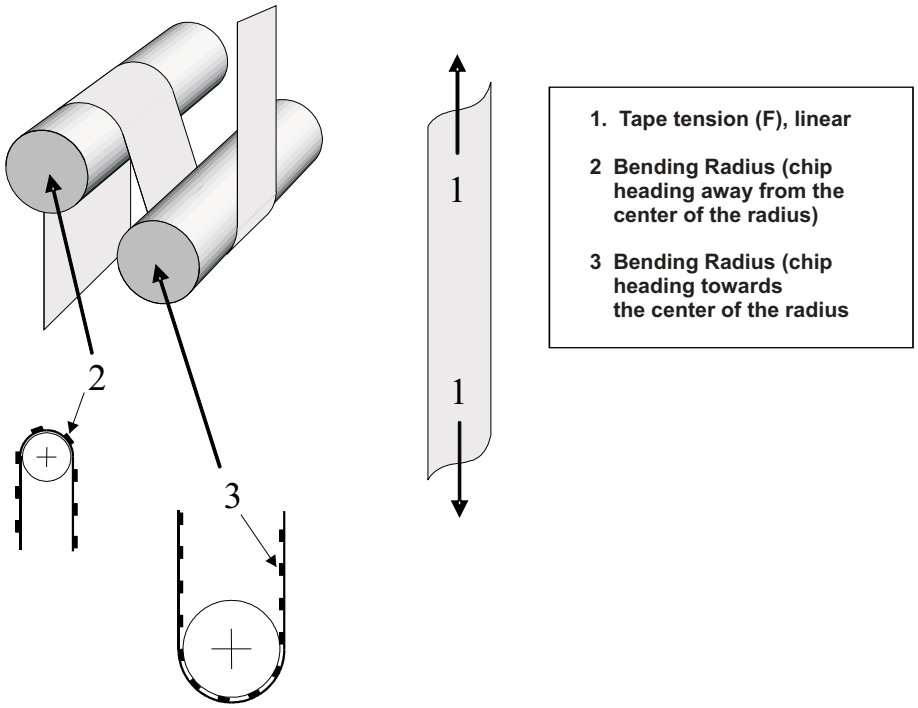

Figure 3-7. Tape Tension and Bending

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Regulatory, Safety, and Warranty Notices

This chapter describes important safety precautions and safety regulations.

Topic **Page**

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4.1 Regulatory, Safety, and Warranty Notices

An RFID system comprises an 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-I Pro Transponder Inlay has been manufactured using state-of-the-art technology and in accordance with the recognized safety rules.

Observe precautions in operating instructions

- Condition for the safe processing, handling, and fault-free operation of the Tag-it HF-I Pro Transponder Inlay is the knowledge of the basic safety regulations.
- All persons who operate the Tag-it HF-I Pro Transponder Inlay must observe the guidelines and particularly the safety precautions outlined in this document.
- 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 apply. 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 nonfunctioning safety and protective equipment
- Failure to observe the instructions given in this document 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 natural disasters.

CAUTION

Tag-it HF-I Pro 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-I Pro 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 deionize the foil to remove the electrostatic charge.

WARNING

Electronic devices can also be destroyed by electrostatic energy.

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4.4 Danger of Cutting Injuries

WARNING

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 3.8.

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Terms and Abbreviations

A list of the abbreviations and terms used in various TI-RFid™ manuals can be found in a separate manual:

TI-RFid™ Product Manual Terms & Abbreviations (SCBU014) (11-03-21-002)

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