EPC™ Gen 2 Smart Label Conversion

TI Gen2 Inlays

Application Note

11-09-26-008

Radio Frequency Identification Systems

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Edition 1.0 – October 2005

This is the first edition of this EPC Gen 2 Smart Label Conversion Application Note. Documentation contains information on inlay conversion requirements with delivery information and product handling considerations for highly reliable Gen 2 smart label solutions for end users. This application note applies to Texas Instruments™ Gen2 inlays based on the EPC Generation 2 specification.

PREFACE

READ THIS FIRST

About This Manual

This **Application Note (11-09-26-008)** is written for the sole use of TI-RFid customers who are engineers experienced with TI-RFid and radio frequency identification (RFID) devices. This application note is not intended as an introduction to RFID.

Conventions

Certain conventions are used in order to display important information in this manual. These conventions are:

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:

Indicates information on conditions that must be met or a procedure that must be followed. If the caution is not heeded, permanent damage to the system could result.

Note:

Indicates conditions that must be met or procedures that must be followed to ensure proper functioning of any hardware or software.

Information:

Indicates conditions that must be met or procedures that must be followed to ensure proper functioning of any hardware or software.

If You Need Assistance

For more information, please contact the sales office or distributor nearest you. This contact information can be found at: **www.ti-rfid.com**.

Introduction

This application note is intended for smart label converters who intend using TI Gen2 inlays to create smart labels. This application note provides details on the electrical and physical characteristics, in addition to packaging, programming and handling information.

TI Gen2 products are based on the globally accepted EPC Generation 2 specification for the retail supply chain. TI Gen2 inlays are designed to provide an easy path for creating smart labels. This application note provides information to enable successful conversion from piloting levels to high-volume production environments. Figure 1 shows single TI Gen2 inlay.

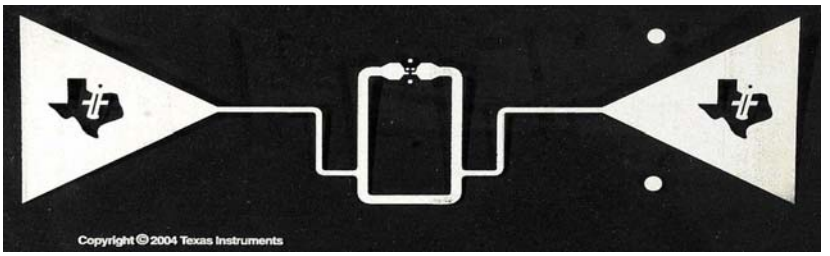


Figure 1. TI Gen2 Inlays

Information:

Because of the high number of variables in any system (reader type, reader power, antenna type, antenna orientation, product characteristics, etc.), the performance information provided in this documentation should be treated as comparative rather than absolute.

EPC Gen 2 Inlay Product Description

Standard Form Factor:

TI Gen2 inlays are designed for ease of integration in the smart label conversion and handling process. TI's inlays feature a TI standard inlay footprint and delivery mechanism and few variations in antenna designs for performance across a wide range of SKUs. Figure 2 shows TI Gen2 inlay width and pitch.

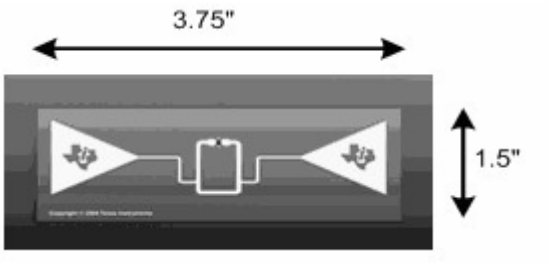


Figure 2. TI Gen2 Inlay Width and Pitch

Table1 lists some physical properties and the overall dimensions for TI Gen2 inlays.

Substrate Thickness	~76 microns [3 mil]
Die Height	~0.28 mm [11 mil]
Antenna Ink Thickness	~4 microns – 6 microns [~0.15 mil – 0.24 mil]
Substrate Material	PET
Substrate Elasticity (Young's modulus)	5 GPa [870 kpsi]
Coefficient of Thermal Expansion (CTE)	6 x10^{-6} °C^{-1} [2.1x10^{-6} °F^{-1}]
Inlay Width	95.25 mm $\frac{+0.00}{-0.10}$ [3.75 in $\frac{+0.000}{-0.004}$]
Inlay Pitch	38.10 mm $\frac{+0.10}{-0.40}$ [1.50 in $\frac{+0.004}{-0.016}$]

Table 1. Inlay Dimensions

Inlay-on-reel Dimensions

Figure 3 illustrates TI Gen2 single row inlays on a reel.

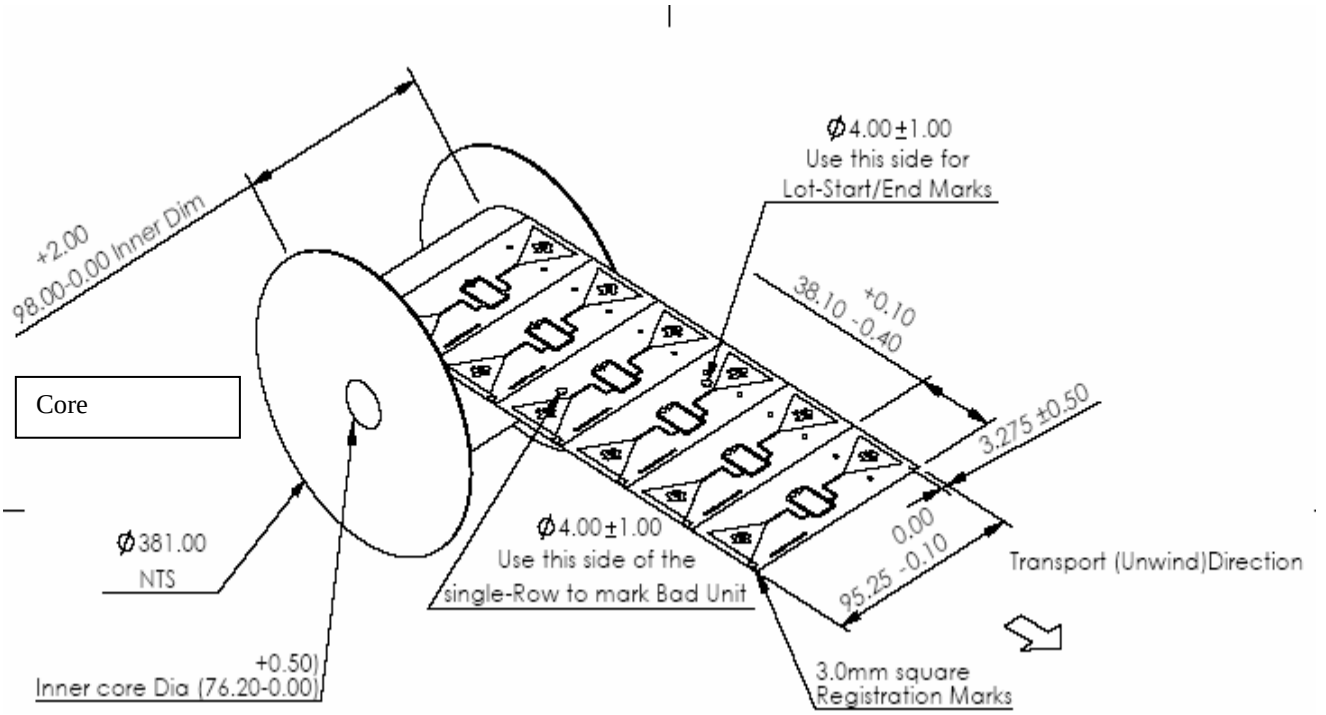


Figure 3. Inlay-on-reel Dimensions

EPC Gen 2 Chip Programming

EPC Gen 2 non volatile memory (NVM)

TI Gen2 inlays have three memory banks as illustrated by figure 4

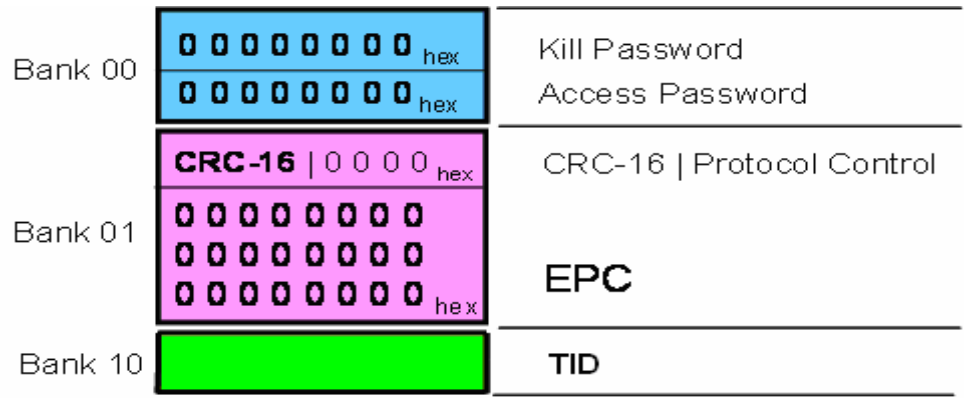


Figure 4. Inlay Memory

EPC Gen 2 Reserved Memory (Bank 00)

This memory is reserved for the “Kill” and “Access” passwords. Unless these locations contain non-zero values, the Kill and Access commands will not be accepted. Furthermore, these locations cannot be locked or made read-protected without invoking the Access command.

EPC Gen 2 Memory (Bank 01)

This area of memory contains a CRC-16 checksum. The CRC automatically generates a checksum value on the PC and EPC data as soon as it enters the RF field.

In the same block is the Protocol Control value. This 16-bit value is returned with the backscattered data and tells the reader the length of the PC + EPC data and the numbering system it uses. Inlays can also be configured to return an application family identifier (AFI) value. The CRC-16 occupies memory locations 0x00 to 0x1F, and the protocol control bits are from 0x10 to 0x1F. Refer to Figure 5 for details on Protocol Control Bits (PCB).

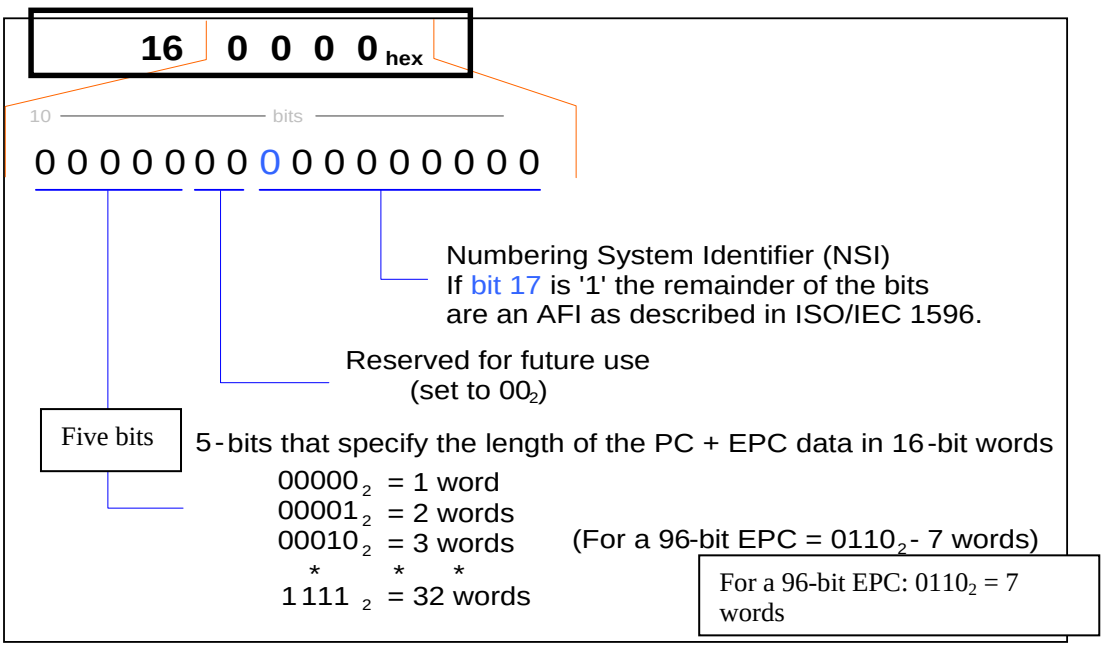


Figure 5. Protocol Control Bits

The NSI structure is defined in the EPCglobal™ document “Tag Data Standards,” version 1.1 Rev 1.27 May 2005 (or later).

TID Memory (Bank 10)

This memory location is used by the chip manufacturers to program TID memory content as outlined by the EPCGlobal Gen2 specification. This memory bank is locked with only read access when shipped to TI customers.

During smart label fulfillment, the following fields will have to be programmed:

1. Kill Password
2. Access Password
3. Protocol Control Bits
4. EPC

Programming 96-bit EPC Data (CPG application environment)

The 96 bits of EPC data are programmed in memory locations 0x20 to 0x7F (MSbit = 0x20). Data should conform to the EPC standard. For a general identifier (GID-96) EPC code, the data is similar to that described in Figure 6.

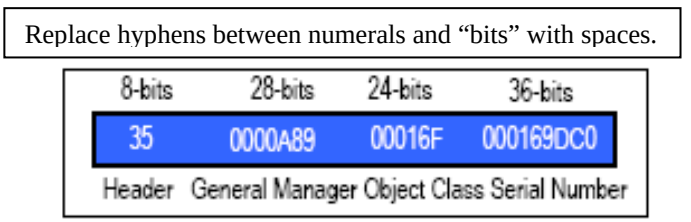


Figure 6. 96 bit EPC Fields

Manufacturers will get their product EPC numbers from EPCglobal™. Refer to: http://www.epcglobalinc.com

EPC Gen 2 Inlay Production Delivery

TI GEN2 Inlay Packaging

The inlays are delivered in a continuous substrate on 15” reels of 10,000 units. There may be multiple splices per reel. Refer to Figure 3.

TI GEN2 Inlay Markings

Inlays are 100% tested, and non-functional inlays will be marked with Ø4-mm ink dots. Figure 3 and Figure 7 show inlay markings.

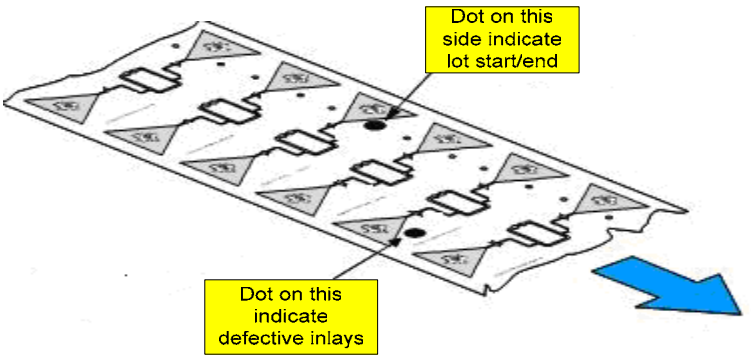


Figure 7. Inlay Markings

Reel Header and Trailer

At either end of a reel of inlays is a one-meter (39”) length of chip-less units. These headers and trailers allow the reels to be loaded onto conversion machines without loosing any functional inlays. The first and last functional inlays are marked with an ink dot as indicated in Figure 7.

EPC Gen 2 Inlay Handling

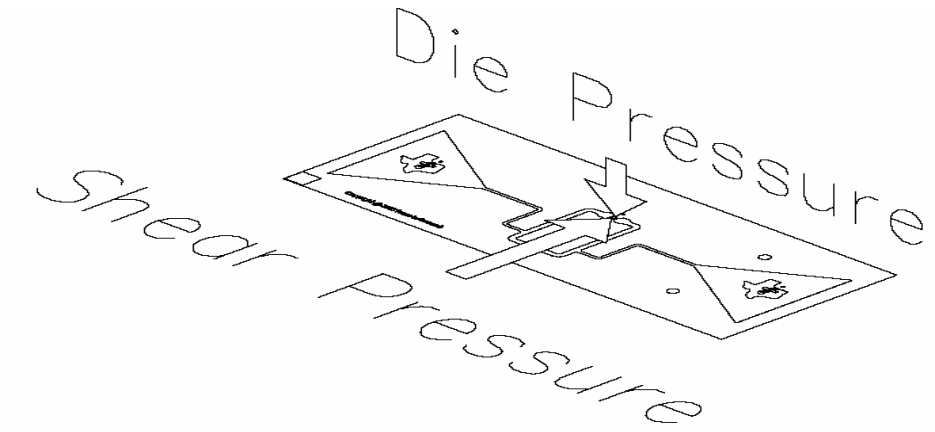


Figure 8. Pressures Applied to Chip

Shear Pressure

Table 2 lists shear pressure, which must be less than 4 (Newton) N/mm^2. Figure 8 defines the direction of shear pressure.

Shear Force (per unit die area)	4 N/mm^2 [580 psi]

Table 2. Shear Force

Pressure in the Chip Area

During the conversion process, the direct pressure applied to the chip must not exceed 10 N/mm^2 as listed in Table 3. Refer to Figure 8 for direction of pressure.

Direct Pressure (per unit area)	10 N/mm^2 [1,450 psi]

Table 3. Pressure on Chip

CAUTION:

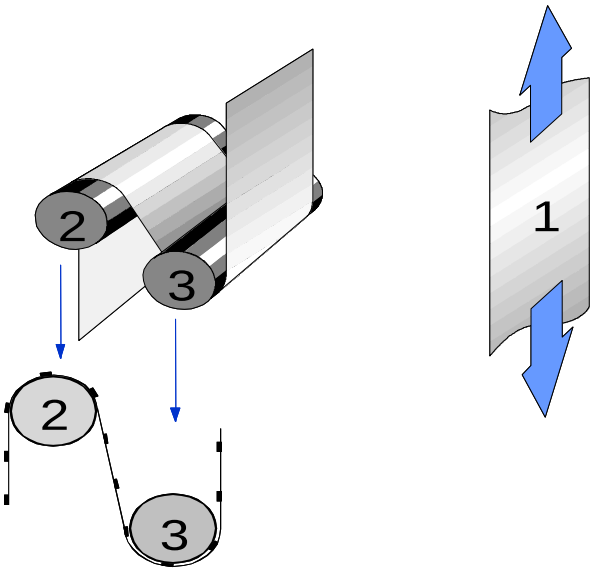
Excessive pressure on the chip will result in the chip/substrate conductor cracking, and excessive shear pressure will cause the chip to detach from the substrate.

Tape Tension and Bending

Table 4 lists the limits that, if exceeded, will result in damage to the inlays. Figure 9 illustrates the three conditions.

	Condition	Limit
1	Max Linear Tension	6 N [1.35 lbf]
2	Min Bending Radius (away from center)	15 mm [0.7 inch]
3	Min Bending Radius (toward center)	15 mm [0.7 inch]

Table 4. Tape Tension and Bending



1 Linear Tension
2 Bending Radius (chip bending away from center of radius)
3 Bending Radius (chip bending toward center of radius)

Figure 9. Tape Tension

Note:

The bending radius is based on a tension of 6 N.

Inlays should not make 180º turns around bars less than Ø30 mm (1¼ inch) diameter.

ESD Precautions

During winding and unwinding operations, the inlays can become electrostatically charged. The high current density of an electrostatic discharge (ESD) from the tape can severely damage the chips. The amount of ESD charge depends on the winding speed and tension. We strongly recommend using the ESD deionization equipment during smart label conversion. Table 5 lists the ESD limits.

ESD Immunity	2.0kV (Class 2, human body model)

Table 5. ESD Immunity