

# EE-150

Electronic Shelf Label



The EE-150 is an e-paper based electronic shelf label with a screen size of 1.54" and with 802.15.4 based wireless communication.

The information in this document is subject to change without notice.

## Document History

Model Number:	EE-150	Original release date	19-05-2016
Revision:	V-0.1	Date	12-9-2016

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## Limited Warranty and Disclaimers

Please read this manual carefully before installing or using the product.

## Serial Number

A serial number appears on all Opticon products. This official registration number is directly related to the device purchased. Do not remove the serial number from your Opticon device. Removing the serial number voids the warranty.

## Warranty

Unless otherwise agreed in a written contract, all Opticon products are warranted against defects in materials and workmanship for two years after purchase excluding batteries. Opticon will repair or, at its option, replace products that are defective in materials or workmanship with proper use during the warranty period. Opticon is not liable for damages caused by modifications made by a customer. In such cases, standard repair charges will apply. If a product is returned under warranty and no defect is found, standard repair charges will apply. Opticon assumes no liability for any direct, indirect, consequential or incidental damages arising out of use or inability to use both the hardware and software, even if Opticon has been informed about the possibility of such damages.

## Packaging

The packing materials are recyclable. We recommend that you save all packing material to use should you need to transport your data collector or send it for service. Damage caused by improper packaging during shipment is not covered by the warranty.

## Trademarks

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## Revision History

Product Name : EE-150

Edition	Date	Page	Section	Description of Changes
V0.0	2016/05/19	-	-	Preliminary Version
V0.1	2016/09/12			Added weight, Removed IP rating, changed FFCID and changed temperature and humidity ranges

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## 1 Abstract

This manual provides specifications for the EE-150 Electronic Shelf Label (hereafter referred to as “ESL”).

## 2 Overview

The EE-150 is an E-ink based ESL with a 2.4GHz radio for data communication. This product uses Direct Sequence Spread Spectrum RF technology that allows for ultra-low power consumption combined with a reduced sensitivity to background noise. That means less interference by other radios that operate in the 2.4GHz band. The radio protocol that is used is based on the IEEE 802.15.4 standard that specifies the physical layer and media access control for low-rate wireless personal area networks.

A development kit is available that consists out of a base station, several ESL tags and PC software that allows people to quickly test the system and makes it easier to integrate this ESL system into an existing back office system.

## 3 Physical Features

### 3.1 Dimensions

W x H x D = 45.5 x 39.9 x 14.8 mm

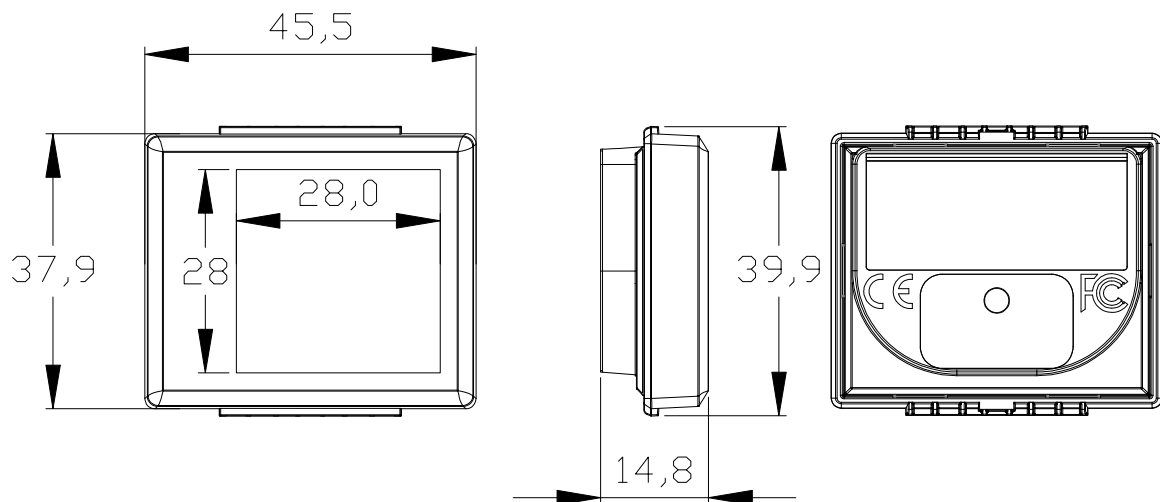


Figure 1: Dimensions

### 3.2 Weight

22.3 g (including battery)

## 4 Environmental Specifications

### 4.1 Operating Temperature and Humidity

Temperature: 0 to 40° C  
Humidity: 20 to 60% RH (Over full temperature range and Non Condensing)

### 4.2 Storage Temperature and Humidity

Temperature: -20 to 50° C  
Humidity: 20 to 60% RH (Over full temperature range and Non Condensing)

### 4.3 Static Electricity

Air discharge:	$\pm 8$ kV MAX (No malfunction) $\pm 15$ kV MAX (No destruction)
Contact discharge:	$\pm 4$ kV MAX (No malfunction) $\pm 8$ kV MAX (No destruction)

## 5 Controls

Items	Specifications		Remarks
CPU	Type	8051 core 8-bit MCU	
	Internal flash ROM	128KB	
	Internal RAM	8 KB	
	Clock frequency	32 MHz	
LCD	Active area	W 27.51 x H 27.51 mm	
	Number of dots	W 152 x H 152	
	Dot pitch	140 Horizontal 140 Vertical	Dots per Inch
Radio	Modulation	DSSS	
	Frequency	2394 ~ 2507 MHz	Globally approved 2.4GHz band.
	Baud rate	250 Kbits / second	



## 6 Electrical Specifications

### 6.1 Electrical Characteristics

Conditions: Operating voltage 3.0V unless otherwise specified

Parameter	Typ	Unit	Remarks
Operating voltage	2.3~3.3	V	One CR2540 Lithium primary battery
Sleep current	1	μA	When the transmitter and receiver are idle
Poll time	>= 20	seconds	See below

The ESL is in sleep mode almost the entire time. The device wakes up at regular intervals (called the poll time) and it then transmits a poll request to the base station. When the base station has no data to send, it acknowledges the poll after which the ESL immediately goes back to sleep. The minimum poll rate is configurable and is set to 20 seconds by default. A higher poll rate will decrease the power consumption but will increase the response time.

### 6.2 Battery

The power is supplied to the ESL by 1 CR2450 battery:

- Nominal capacity: 600 mAh
- Nominal voltage: 3.0 V.
- Maximum self-discharge rate: <1% per year
- Battery life: 4 years minimum (Update frequency: 4 times per day, poll time 20 seconds). A more detailed set of conditions is listed in the table below.

The battery life is made up of several factors. During transmission e.g. the current consumption is much higher than when the ESL is 'sleeping'. The table below shows the various factors that make up the entire current consumption, plus the conditions under which the lifetime calculation was done.

Factor	Conditions	Correlation *	Influence **
Data communication	Poll interval: 20 seconds Retransmissions: 10% Report ratio: 1 to 39	Yes No Yes	61%
Display updates	4 updates per day Temperature: 15~25° C	No Yes	20%
No connection with base station (Out of range or base station off)	Not connected: 2% Number of channels: 5	No No	4%
Sleep time	99,9%	Yes	9%
Battery self-discharge	1 % / year	No	6%

\* The correlation shows whether increasing the listed value under 'Conditions' increases (Yes) or decreases (No) the battery life of the EE-150.

\*\* The influence shows the percentage of the specified factor on the entire current consumption.

For example:

- Increasing the poll interval improves the battery life
- Turning off the base stations shortens the battery life.
- A lower operating temperature (below 15° C) shortens the battery life.
- More display updates per day shortens the battery life.

## 7 Radio Specifications

Parameter	Min	Typ	Max	Unit	Remarks
Receiver sensitivity		-97	-89	dBm	Over the entire temp. and operating voltage range
Nominal output power	-3	4.5	7	dBm	
Frequency	2405		2480	MHz	Over the entire temp. and operating voltage range
Transfer rate		250Kbit/s			
RSSI range		100		dB	Signal strength indication that can be reported to the base station

### 7.1 Protocol

Modified 802.15.4 (Physical layer and Media Access Control layer).

#### 7.1.1 The physical layer

The physical layer (PHY) provides the data transmission service, as well as the interface to the physical layer management entity, which offers access to every layer management function and maintains a database of information on related personal area networks. Thus, the PHY manages the physical RF transceiver and performs channel selection and energy and signal management functions. It operates on the above mentioned frequency band. The PHY layer is 100% compliant and is based on direct sequence spread spectrum (DSSS) technique with a transfer rate of 250 kbit/s.

#### 7.1.2 The medium access control layer

The medium access control (MAC) layer enables the transmission of MAC frames through the use of the physical channel. Besides the data service, it offers a management interface and itself manages access to the physical channel. It also controls frame validation, guarantees time slots and handles node associations. Finally, it offers hook points for secure services. The EE-150 does not make use of the optional network beaconing, instead it uses a polling mechanism to increase power efficiency. Some changes are made to the standard to allow for more efficient data frames and better power efficiency, especially when nodes are not connected to a base station.

### 7.2 Security

By default only the image transmission is encrypted using a proprietary encryption protocol. Enhanced encryption/authentication can be requested on demand by loading different firmware on the ESLs in combination with the loading of an encryption key and an additional ESL server module. The protection method for RF-communication is done by 128-bit AES encryption.

## 8 Labeling

### 8.1 Product Label

The product label is affixed to the ESL as shown below.



Figure 2: Product Label

**Label material:**

Material: Base + laminate protection against wear.  
 Base: PP film, thickness 80µm, backing with glue.  
 Laminate: PET film, clear, thickness 25µm.  
 RoHS compliant

**Label dimension:**

20.4mm x 12.4mm (w x h)  
 Tolerance ± 0.1mm  
 Corner radius 2.7mm

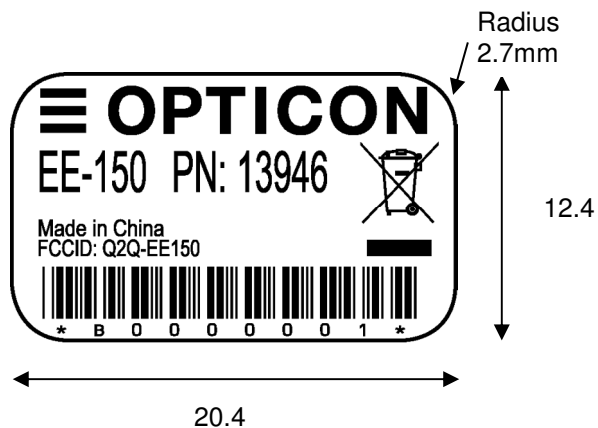
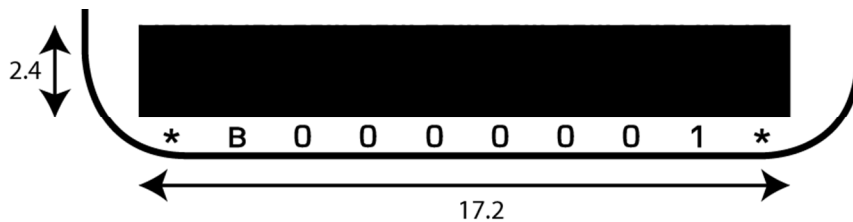


Figure 3: Product Label dimensions

**Barcode area:**

The size of the barcode area (without the human readable part) is 2.4 x 17.2mm).  
 The barcode shows the product serial number. This is a 'B' followed by 7 hexadecimal digits.  
 This serial number is the same as the MAC address in the ESL-label, with the first 9 digits ('3889DC000') replaced by a 'B'.



## 8.2 Shipment Box Labels

The shipment box labels are meant to show the regulatory information on the shipment box as well as the quantity in the box. The labels are 105mm\*160mm and are made from plain paper with adhesive backing.

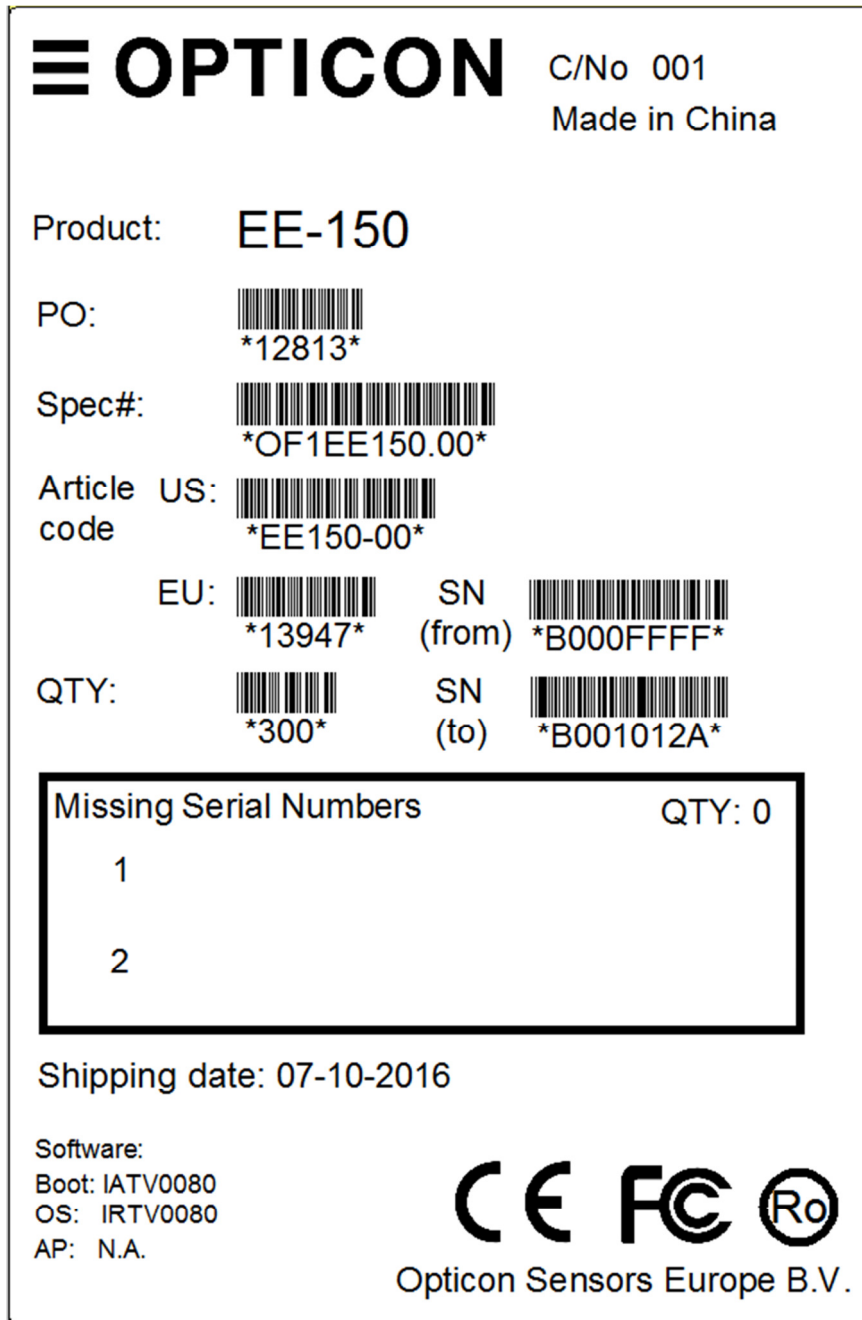


Figure 4: Shipment box label

This is the standard Opticon shipping label, design rev2 and the various variable fields in the above drawing are indicative only.

## 9 Packaging Specifications

### 9.1 Individual Packaging Specification

The ESL's do not need to be packed separately. To easily pack them, 30 need to be packed in a plastic moulded tray:

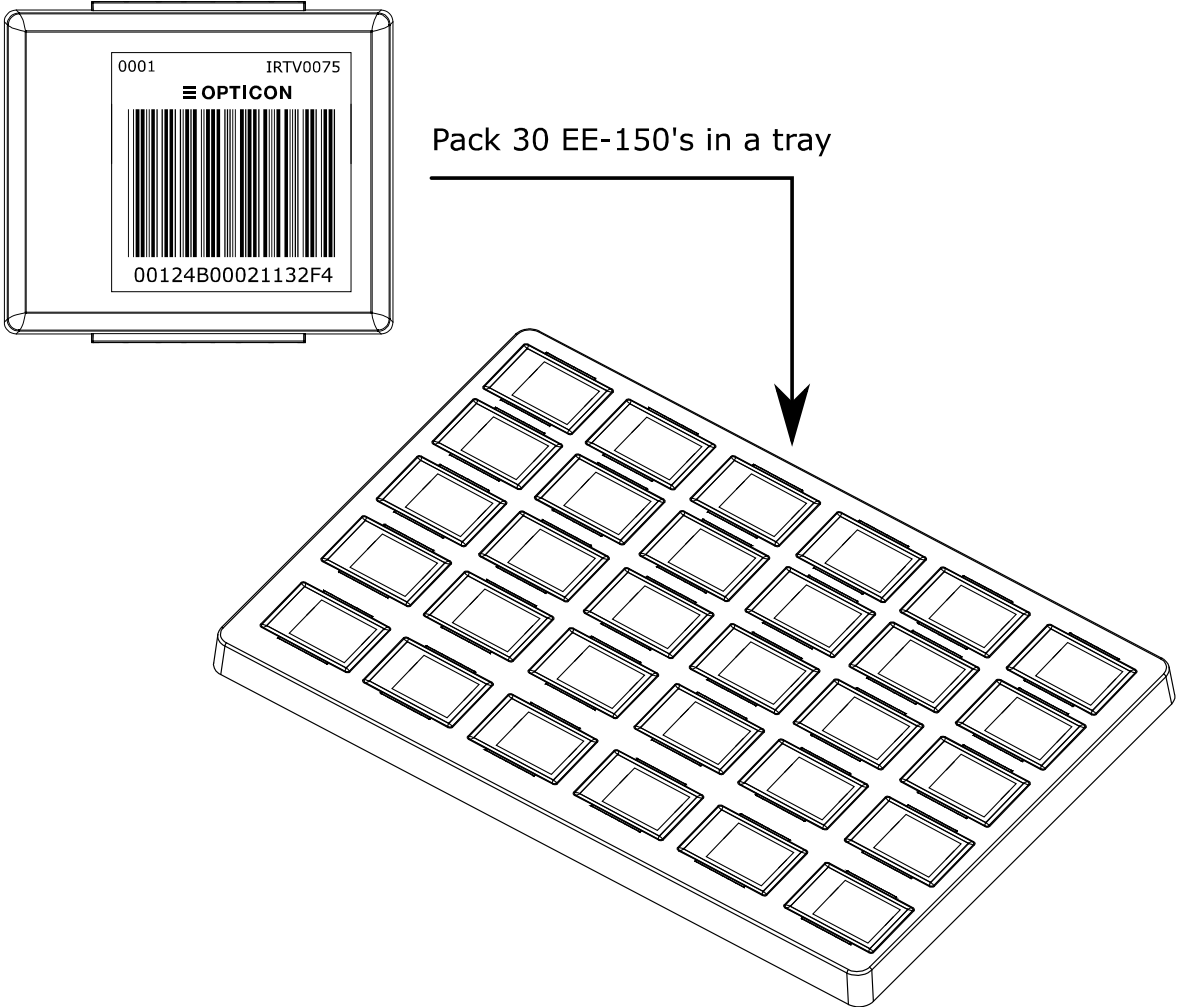


Figure 5: Individual packaging

### 9.2 Collective Packaging Specification

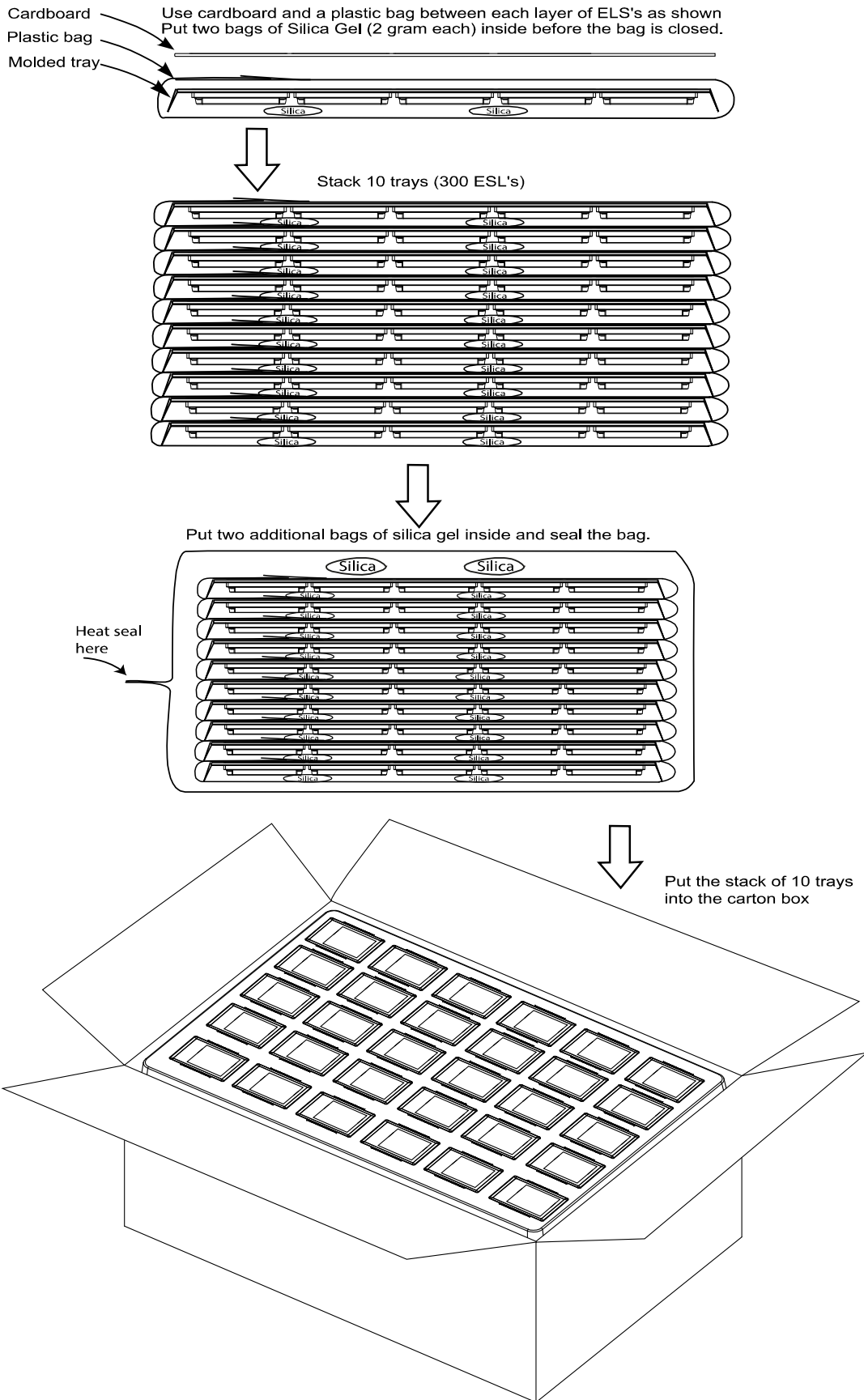


Figure 6: collective packaging

### 9.3 Collective Shipment Packaging Specification.

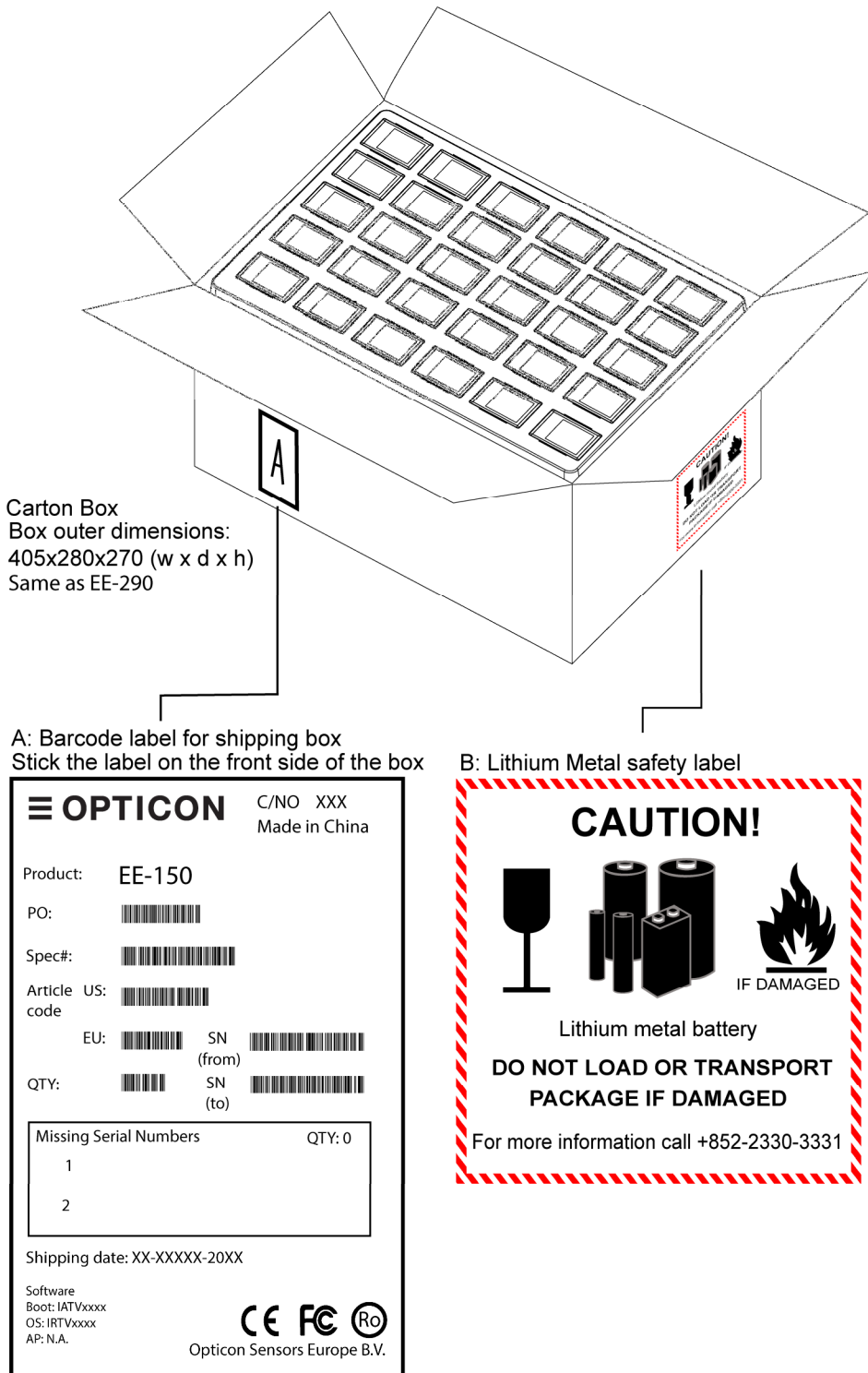


Figure 7: collective shipment packaging

Note: The “RO” mark labeled on the package tray or package box guarantees that the applicable product has passed our test of RoHS restrictions compliance (the restriction of the use of certain hazardous substances in electrical and electronic equipment, 2002/95 EC). However, this document does not have any legal weight in the European Union.

## 10 Regulatory Compliance

### 10.1 Product Safety

EN 60950-1:2006+A11:2009+A1:2010+A12:2011+A2:2013  
IEC 60950-1:2005 (2nd Edition)+Am 1:2009+Am 2:2013

### 10.2 EMC

EN55022: 2010

EN55024: 2010

#### **Federal Communications Commission (FCC) Statement**

15.21

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

15.105(b)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause interference and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

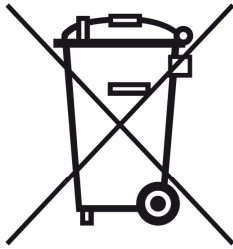
#### **RF Radiation Exposure Statement:**

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body.



### 10.3 WEEE

Waste Electrical and Electronics Equipment Directive, 2012/19/EU.



**Following information is only for EU-member states:**

The use of this symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about recycling of this product, please contact your local council, your household waste disposal service or the shop where you purchased the product.

### 10.4 RoHS

RoHS: The restriction of the use of certain hazardous substances in electrical and electronic equipment, 2011/65 EC.

## 11 Safety

Handle this product carefully. Do not deliberately subject it to any of the following.

### 11.1 Shock

Do not throw or drop the ESL.  
Do not place heavy objects on the ESL.

### 11.2 Temperature Conditions

Do not use the ESL at temperatures outside the specified range.  
Do not pour boiling water on the ESL.  
Do not throw the ESL into the fire.  
Do not leave the ESL on the dashboard of a car.

### 11.3 Foreign Materials

Do not immerse the ESL in liquids.  
Do not subject the ESL to chemicals.

### 11.4 Disposal / Battery

Replace the ESL when its lifetime has expired. This is after max. 10 years of operation or sooner when the battery is depleted. When the battery is depleted, discard the complete product with the battery and replace the ESL with a new one. When discarding the product, treat it as chemical waste and dispose of it according to local regulations.

**CAUTION**  
**RISK OF EXPLOSION IF BATTERY IS REPLACED**  
**BY AN INCORRECT TYPE.**  
**DISPOSE OF USED BATTERIES ACCORDING**  
**TO LOCAL REGULATIONS**

### 11.5 Other

Do not disassemble this product.  
The ESL may be damaged by high voltage discharges.

### 12 Mechanical Drawing

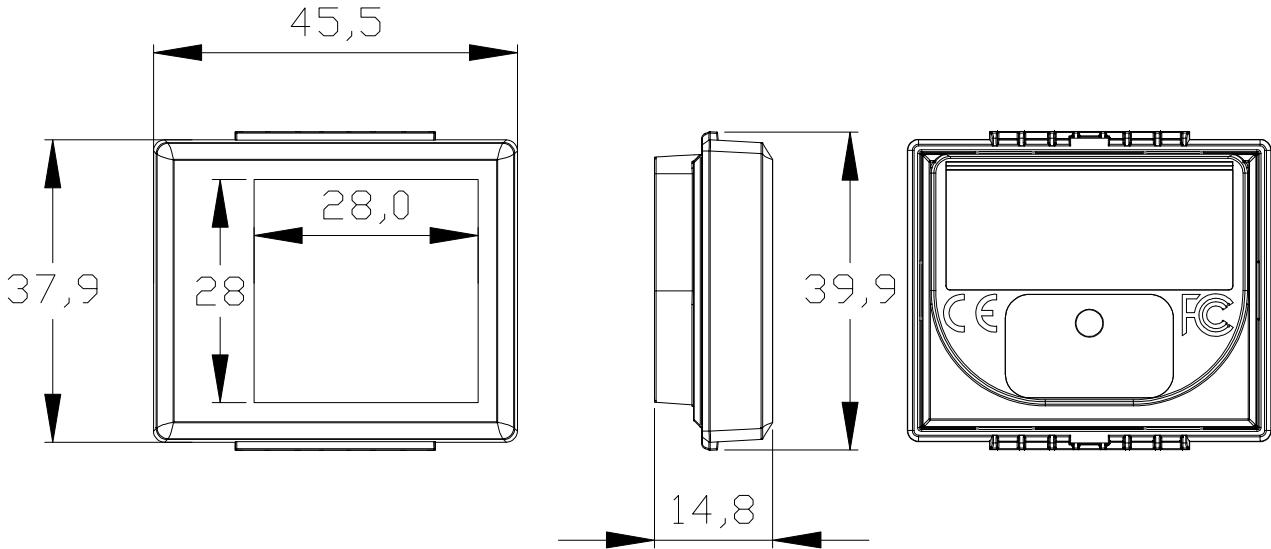


Figure 8: Mechanical drawing