

Product-Category Rules (PCR)
for Preparing an Environmental Product
Declaration (EPD) of
Printed Circuit Board Assembly
PCR 2011:1.0

Lite-On Technology Corporation

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1. General Information

This document is to be used as the product category rules (PCR) for the global production and manufacturing of printed circuit board assembly (PCBA). The requirements specified in this PCR are intended to be used for EPDs certified in accordance with ISO 14025 standard. This document shall be valid until Jun 13, 2013.

This PCR was jointly prepared by Lite-On Technology Corporation and Taiwan Green Productivity Foundation. Representatives from major Taiwanese manufacturers of similar products and stakeholders were invited by the Taiwan Electrical and Electronic Manufacturers Association (TEEMA) to the open consultation meeting on May 19, 2011, to participate in the discussion and review of this PCR. Environment and Development Foundation (EDF) then reviewed and approved this PCR.

This PCR is applicable to products with the Harmonized System (HS) Code of 8471.60, 8471.80, 8473 or 8529.

For further information and comments concerning this PCR, please contact Ladios Liu, Green Policy & System Support Center, System Solution Business Unit, LITE-ON TECHNOLOGY CORPORATION (Tel : +886-2-2222-6181#3027 ; Fax : +886-2-2222-3559 ; email : ladios.liu@liteon.com) °

2. Company and product description

The EPD shall include information about the manufacturing company/organization. The information may include manufacturing process related information, and environmental related information, such as the environmental management system information. The information may also include special issues which the company/organization would like to emphasize, such as the products meeting certain environmental criteria, or environmental safety and health related information.

This PCR is applicable to both business to business (B2B) and business to consumer (B2C) communications.

The products covered in this PCR also include their packaging.

(Note: B2B refers to operations or transactions among businesses, which only include part of the product transactions, such as procurement, inventory management, payment, distribution and technical support activities; while B2C refers to transactions or interactions between businesses and their customers, which cover the whole product transaction process, including communicating product information to customers or consumers, delivery of products through logistic system to customers/consumers, and waste disposal for end-of-life products, etc.)

2.1 Product group function

The integrated circuit board assembly (PCBA) consists of a variety of electronic components which are mounted onto the printed circuit board (PCB) through the use of soldering technology, such as the surface mount technology (SMT) or wave soldering technology. The PCBA is capable of linking electronic signals from these electronic components to form a single or composite electronic signal computing platform, as well as connecting peripheral components, such as central

processing unit (CPU), LCD panel, hard disk drive, optical drive device, power supply, input and output devices or other PCBA to form an electronic or electrical product.

2.2 Product components

In addition to the PCB, a PCBA may also include but not limited to the following main components:

- Active Components: e.g., integrated circuit (IC), transistor, diode, memory module;
- Passive Components: e.g., resistor, inductor, capacitor;
- Mechanical Components: e.g., connector, thermal module, protection/fixing components, jumper;
- Battery;
- Cable;
- Antenna module;
- Packaging material.

Components not listed above are considered minor/secondary components, such as the user manual or labels.

The data quality requirements for the main and secondary components are described in Section 9 on calculation rules and data quality requirements.

2.3 Product technical description

The product technical description part of the EPD shall include the following information:

- Product Name and Type Code
- Product Function Specification
- PCB Specification: e.g., Rigid/flexible board, layers, main materials, flammability classification, etc.
- Input/Output Interface Specification
- Product Dimensions: L (mm)*W (mm)*H (mm)
- Product Weight
- Design Using Life or Guarantee Life
- Others: e.g., operating voltage, working temperature, power rating, and application limitation.

3. List of materials and chemical substances

The contents of the following materials and substances in the product shall be declared:

- All materials of the product (excluding packaging material) with weight ratio (material weight/product weight) $\geq 1\%$;

- All materials of the packaging with weight ratio (material weight/packaging weight) $\geq 1\%$;
- All materials/substances in the product (including packaging) regulated by legal and customer requirements;
- The following materials in the product components: flame retardants, lead content in solder, lead and flame retardant content in solder masking agent, and substances regulated by EU's RoHS Directive (the latest version).

The declaration of halogen-free flame retardants, lead-free solders and no RoHS-regulated substances may only be made when appropriate evidences are available (for example, test reports from accredited laboratories/testing facilities). The following organizations may provide accreditation for testing facilities: Taiwan Accreditation Foundation (TAF), (Asia Pacific Laboratory Accreditation Cooperation (APLAC), International Laboratory Accreditation Cooperation (ILAC) or ILAC Mutual Recognition Arrangement (ILAC MRA). For definitions of testing methodology and confirmations of regulated hazardous substances based on the accredited laboratories' product testing methods, please refer to IEC 62321 Standard.

4. Declared unit

The declared unit is one "piece" of PCBA, as the PCBA products are marketed and sold in such a unit.

5. System boundaries

The main system boundaries for the declared product system are presented as follows:

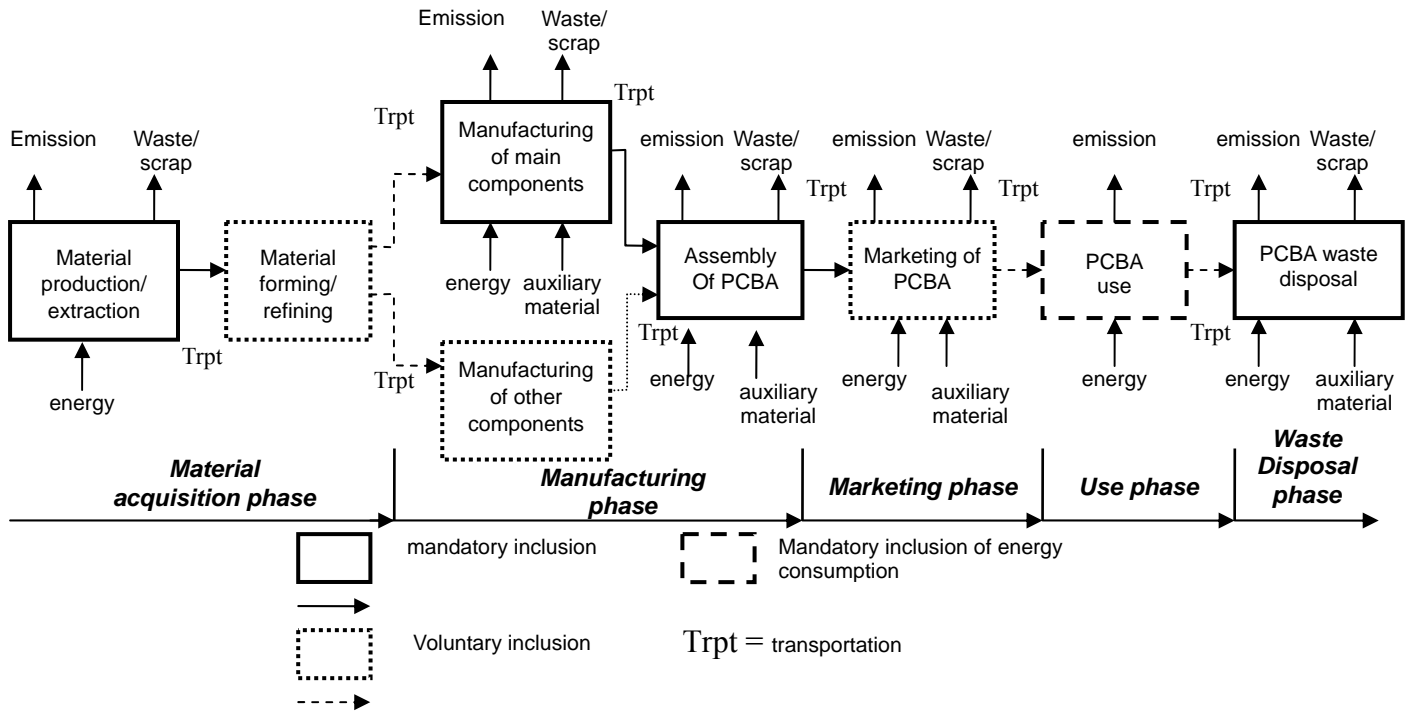


Figure 1 System boundary of the product system

As noted in Figure 1 above, if the EPD of a PCBA is used for B2B purpose, its life cycle only covered two stages: raw material acquisition and product manufacturing. If the EPD is to be used for B2C purpose, it will cover five stages of the product life cycle: raw material acquisition, product manufacturing, distribution, product use and waste disposal.

Raw Materials Acquisition and Manufacturing Stage

The LCA shall include information for the following unit processes:

- Material extraction and manufacturing of main components and other components;
- The production/generation of energy used for raw material manufacturing.

The inclusion in the LCA the information on the forming and refining of raw materials and transportation of raw materials is of voluntary reporting nature.

Manufacturing Stage

The LCA shall include information for the following unit processes:

- Manufacturing of main components and transportation of process waste to waste disposal plants;
- Assembly of products and transportation of process waste to waste disposal plants;
- Transportation of main components to PCBA manufacturing site.

The inclusion in the LCA the information on the input/output of packaging material during main components manufacturing process and the manufacturing of minor/secondary components/parts is of voluntary reporting nature.

Distribution Stage

The LCA shall include information for the following unit processes:

- Products' distribution transportation.

Besides the distribution transportation, the inclusion in the LCA the information on the input/output of all energy/resources and waste generation/discharge and transportation of marketers during the distribution stage are of voluntary reporting nature.

(Note: The distribution transportation means the shipping of products to logistics centers, retailers or customer designated locations; while marketing transportation means the transportation from terminal sites of the distribution stage to the sites where end-users or customers obtain the products.

Use Stage

As PCBA is a main component of electrical and electronic products, its energy consumption shall be calculated according to the assumed usage scenario of the end products which the PCBA is a part of, and based on the applicable industrial or international testing standards. The following energy consumption equation may be used:

$$\text{Energy consumption of PCBA (kWh)} = (\text{input power (W)} - \text{output power (W)}) \times \text{design life of PCBA} \times 0.001 \text{ (kW/W)}$$

The inclusion in the LCA the information on the product maintenance during use stage, and transportation of waste to waste disposal site during end-of-life stage is of voluntary reporting nature.

Recycling/end-of-life Stage

The reporting of recycling information (such as recycling and dis-assembly report and information on recycling channels) is mandatory in the EPD. Also, the environmental impact shall be calculated based on the declared recycling rate.

5.1 Specification of different boundary settings

Boundary in time

The validity period for the LCA results presented in the LCA report shall be defined.

Boundary towards nature

If the manufacturing processes are located within Taiwan, the solid waste categories as defined in Taiwan's Waste Disposal Act shall be adopted. If the processes are located in other countries, equivalent legal requirements shall be considered.

The natural boundary of the system shall describe the boundary where the materials and energy resources flow from nature into the system, and where the water and air emissions and waste are released out of the system.

Only the waste which is required to be disposed of needs to be considered; landfilling process does not need to be included. If the waste will be treated through water treatment or incineration, these processes need to be included.

Boundaries in the life cycle

The boundaries in the product life cycle are described in Figure 1. The construction of the site and infrastructure, as well as the production of manufacturing equipment and activities of the workers, does not need to be included.

Boundaries towards other technical systems

Boundaries towards other technical systems describe the inputs of material and other components towards other systems, as well as outputs of materials towards other systems. For the inputs of recycled materials and energy towards the product manufacturing stage, the transportation between the recycling process and use of recycled materials shall be included in the data set. For the production of recyclable products during the manufacturing stage, the transportation towards the recycling process shall be included.

(Note: Further explanations are provided in Section 7 on open-loop recycling)

Boundaries regarding geographical coverage

The manufacturing stage may cover manufacturing processes located on any sites around the world. For processes located in a specific region, the data used should be representative of the region. The data for the main components shall be the specific regional data for the region where the process takes place (see Section 9). For ease of comparison, no matter where the emissions are generated, the same environmental impact parameters should be used for life cycle impact assessment (see Section 10).

6. Cut-off rules

For any impact category, if the sum of various impacts from a specific process/activity is less than 1% of the impact equivalent in that category, such a process/activity may be neglected during the inventory analysis. Nonetheless, the accumulated impact of neglected process/activity may not exceed 5%. Components and materials omitted from the LCA shall be documented.

(Note: This judgment for this “1% Rule” is based on the environment relevance assessment of material input to the system, and does not consider special and exceptional environmental impacts.)

7. Allocation rules

The main allocation rules shall be valid for the entire product system. For other secondary processes, other allocation rules may be defined; however, the use of these rules should be justified. Product-specific information should be preferentially collected in order to avoid the need for allocation. While selecting allocation rules, the following principles are recommended.

- Multi-output: The allocations are based on the changes in the resource consumption and pollutant emissions (for example, adopted quantity allocation for some main component, or surface allocation for some components), following the changes in the studied system's output product or function or economical relationship.
- Multi-input: The allocation is based on actual relationship. For example, the manufacturing process's emissions may be affected by the change in waste flow input.

- **Open loop recycling:** For the input of recycled materials or energy during the manufacturing stage of the product system, the transportation between the recycling process and the recycling to material use shall be included in the dataset. For the product which shall be recycled during the manufacturing stage, the transportation towards the recycling process shall be included.

Notes:

- *Allocation may be avoided through avoidance of dividing processes, for example as described in Section 6.3 of ISO/TR 14049; or through expansion of system boundary (for example as described in Section 6.4), so that the amended system shares the same product exchanges as the original system.*

8. Units

The base units and derived units of the International System of Units (SI, *Système International d'unités*) shall be used preferentially.

Power & energy units:

- power unit: W
- energy unit: J

Specification units:

- length unit: m
- capacity unit: m³
- area unit: m²
- weight unit: kg

If necessary, prefixes may be used before the SI units.

- 10⁹ = giga, symbol “G”
- 10⁶ = mega, symbol “M”
- 10³ = kilo, symbol “k”
- 10⁻² = centi, symbol “c”
- 10⁻³ = milli, symbol “m”
- 10⁻⁶ = micro, symbol “μ”
- 10⁻⁹ = nano, symbol “n”

9. Calculation rules and data quality requirements

Date quality requirements for the raw material acquisition stage

- Generic data may be used for the acquisition, production, forming and refining of raw materials used for the components of the PCBA products. Please refer to Appendix I for the common sources of generic data. The date of the generic data used can not be older than 1990.

Date quality requirements for the manufacturing stage

- Site specific data (for example, specific process data for SMT or wave soldering process) shall be used for the manufacturing of components and assembly of the PCBA product. If other types of information are used, description of the information and rationale for using the information shall be provided. Data from a representative manufacturing site of a specific main component may be used as the site specific data for that component.

- Generic data may be used for the manufacturing process for the packaging material and secondary/minor components of the PCBA products which are calculated based on the actual consumption of such materials. Please refer to Appendix I for the common sources of generic data. The date of the generic data used can not be older than 1990.
- When generic data are used, the equivalence between the chemical and/or physical process of referred systems shall be considered. The system referred in the generic data should have equivalent technology and system boundaries with the declared product system. Moreover, it is also recommended to consider the date or geographic aspects of the data quality.
- Generic data may also be used when suppliers refuse to provide specific data, or when even if generic data are used in place of specific data, there is only minor impact to the results. The general rule is that if generic data are used in place of specific data, their combined contribution for all life cycle stages shall not be greater than 20% of total impacts for each impact category. But there may be certain exception to specific products, and such exceptions shall be explained.
- The data shall be representative for the average of a specific year. If the average data for a specific year can not be obtained, the average data for a specific time period may be used. But the data shall be representative, and the reason for using such data shall be provided.
- The electricity mix for the manufacturing stage should be site specific data. If site specific data cannot be obtained, the official electricity mix for the country where the site is located may be used as approximate value. The electricity mix should be documented.
- For the definition of hazardous waste, the definition as defined in Taiwan's Waste Disposal Act shall be used for sites located in Taiwan. For sites located outside Taiwan, legal requirements for the host country shall be observed.
- For the transportation of main components to the PCBA assembly plant, the actual transportation modes used and distance traveled shall be considered.

Date quality requirements for the distribution and marketing stage

- For the transportation of PCBAs to the distribution sites or retailer sites, the actual mode of transportation and distance traveled shall be considered.

Date quality requirements for the use stage

- The energy consumption of the PCBA shall be determined based on testing methodology stipulated in applicable international or industrial standards.
- For the electricity mix for the use stage, the official electricity mix for the country where the PCBA is exported may be used as approximate value. Please refer to Appendix I for the common sources of generic data. The date of the generic data used can not be older than 1990.

Date quality requirements for the recycling/end-of-life stage

- Generic data may be used during the recycling/end-of-life stage, if for specific reason the site specific data for the recycling/waste disposal system can not be obtained. Then generic data and recycling rate may be used to calculate environmental impact. Please refer to Appendix I for the common sources of generic data. The date of the generic data used can not be older than 1990.

10. Parameters to be declared in the EPD

The following parameters shall be declared in the EPD:

1. Energy use

- The energy consumption during each stage shall be declared. If the EPD is to be used for B2C communication, based on the description of use stage in the system boundary, the energy usage scenario for end-product use and adopted testing methodology as well as applicable industrial or international standards shall be declared.
- The following units shall be used preferentially:
kW or W for power; J or MJ for energy.

2. Resource use

The information on resource input within the system boundary shall be declared.

3. Impact equivalents expressed as potential environmental impacts

-Global warming	kg CO ₂ equivalent
-Acidification	kg SO ₂ equivalent
-Photochemical oxidant formation	kg C ₂ H ₄ equivalent
-Eutrophication	kg PO ₄ ³⁻ equivalent
-Ozone depletion	kg CFC-11 equivalent

Note: For characterization factors of each impact category, please refer to *EPD Supporting Annexes*, Version 1.0 (2008-02-29), The International EPD Cooperation, downloadable from www.environdec.com.

4. Additional information

- Recyclable materials (optional)
- Information on secondary materials (optional)
- Waste (classification):
 - Hazardous waste as defined in Taiwan's Waste Disposal Act. Follow host countries' laws for sites outside Taiwan.
 - Other waste.
- Plastic parts marking

Where technologically possible, plastic parts of the PCBA weighing ≥ 25 g shall be marked in accordance with the ISO 11469 and ISO 1043 Part 1/2/3/4, SPI or other international standard label to facilitate their identification and recovery at the end of life.

- Plastic packaging materials marking

The Plastic packaging materials shall be labeled on the parts with SPI or other international standards for ease of sorting.

11. Recycling information

The recycling information shall include information such as dis-assembly instructions, which parts/components are suitable for recycling (such as metals) or not suitable for recycling. The information which the EU WEEE Directive requires the end product manufacturer to provide may also be included in the product declaration information for PCBA products.

If feasible, information for the parts which can not be recycled and therefore should be disposed of properly during the end-of-life stage may also be included.

12. Other environmental information (Optional)

The EPD may cover information including technology adopted, site of product manufacturing and assembly, as well as information on other working environment, health and risk-related aspects.

If this PCR is to be used for product carbon footprint declaration purpose, in the declaration, information regarding commitment on GHG reduction should be included and shall ensure that the commitment is measurable, reportable and verifiable. The organization may also list environmental and energy management related information, such as awards, commendations and system certifications (e.g., ISO 14001, ISO 14064-1, IECQ HSPM) etc.

13. Information about the certification

The information on PCR review, EPD verification and verification organization shall be included.

EPD Certification is valid until 201_ - _ - _	
According to the Requirements for the international EPD system. General Programme Instructions, Version 1 (2008) – www.environdec.com	
The PCR review for _____ (PCR 201_ :) was administered by the Environment and Development Foundation and carried out by an LCA expert panel chaired by Dr. Ning Yu (ningyu@edf.org.tw). Independent verification of the declaration, according to ISO 14025:2006	
<input type="checkbox"/> Internal <input checked="" type="checkbox"/> External	
Third party verifier: Environment and Development Foundation in Taiwan.	
Accredited by :	
Name:	
Title:	
Organization:	Signature: _____
Name:	
Title:	
Organization:	Signature: _____
Name:	
Title:	
Organization:	Signature: _____
Environmental declarations from different programmes may not be comparable.	

14. References

The EPD shall make reference to the following documents:

- EPD General Program Instructions, Version 1.0 (2008-02-29), The International EPD Cooperation, downloadable from <http://www.environdec.com/>;
- Relevant PCR documents;
- The underlying LCA report.

When available, the following documents shall also be referenced:

- Other documents and recycling instructions which verify and complement the EPD.

Appendix I – Generic Data Sources to Refer to

For processes located within Taiwan, Taiwan generic data or the data published by the commercial, industrial and energy competent authorities of the Republic of China (ROC) government, may be used. However, for other regions (such as EU), if there are more relevant generic data available, these data should be used instead.

When data from the following generic databases are used, the most current and updated data should be used:

Material	Database	Published
Industrial processes	Ecoinvent 2nd edition	2007
Packing materials, transport, waste treatments	BUWAL 250, 2nd edition	2004
	Ecoinvent 2nd edition	2007
Steel, Primary copper, Copper products, Electricity, Fuels, Aluminium, Chemicals, Transports, Waste management,	PE-GaBi	2006
	ELCD version 2.0	2009
	Ecoinvent 2nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000
Plastics	PE Plastics Europe (Association of Plastics Manufacturers in Europe)	1993-1998
	PE-GaBi	2006
	ELCD	2009
	Ecoinvent 2nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000
Electronic components	PE-GaBi	2006
	ELCD	2009
	Ecoinvent 2nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000

Appendix II – Reporting Format for the EPD

This appendix provides guidance information for the titles of sections, types of data and required information to be reported in the mandatory reporting part of the EPD. As a generic reporting template, the following titles and sub-titles are recommended:

(Refer to the PCR manual for the section numbering, the information in Italics are the recommended data/information for inclusion)

Introductory part

Each EPD should have an introduction part on the top part of the EPD which includes the following information:

- *Company/organization name*
- *Product name*
- *EPD registration number*

Description of the company/organization and product/service

Company/Organization

- *Description of company/organization*
- *Description of overall working environment, existing quality system and environmental management system*

Product and services (see Section 2)

- *Product's main applications*
- *Description of product specification, manufacturing process, manufacturing sites (if there are several sites)*
- *For product's environmental performance aspects, characteristics which may improve the usefulness of product*
- *Other types of relevant information, for example, special manufacturing processes with special advantages to the environment*

List of materials and chemical substances

- *Content declaration (see Section 3)*

Presentation of the environmental performance

- *Outline of the LCA methodology, for example, period of LCA, declared units, system boundaries (graphical presentation), cut-off and allocation rules, and data sources.*

Manufacturing stage (see Section 10)

Use stage (see Section 10)

- *Geographical region for product delivery*
- *Transportation data*
- *End-of-life information*

Information about Company and Certification Organization

Recycling information (see Section 11)

Other environmental information (see Section 12)

Information regarding certification

- *Names of certification and verification organizations*
- *Validity of certification certificates*
- *Compliance with legal and relevant requirements*

References (see Section 14)

- *relevant PCR documents*
- *EPD General Program Instructions, Version 1.0 (2008-02-29)*
- *underlying LCA study*
- *other supporting documents for LCA information*
- *other relevant documents regarding company/organization's environmental activities*

Appendix III Abbreviations

Acronyms	Common Name
APLAC	Asia Laboratory Accreditation Cooperation
B2B	Business to Business
B2C	Business to Consumer or Business to Customer
CFP	Carbon Footprint of Products
CPU	Central Processing Unit
ELCD	European Reference Life Cycle Database
EPD	Environmental Product Declaration
GHG	Greenhouse Gas
HS Code	Harmonized System Code
HSPM	hazardous substance process management
IC	Integrated Circuit
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Cooperation
ILAC MAR	International Laboratory Accreditation Cooperation Mutual Recognition Arrangement
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PCR	Product Category Rule
RoHS	The Restriction of the use of certain Hazardous Substances in electrical and electronic equipment
SI	Système international d'unités (French)
SMT	Surface Mount Technology
SPI	Society of the Plastics Industry
TAF	Taiwan Accreditation Foundation
WEEE	The Waste Electrical and Electronic Equipment Directive