

GS1 Standards

Circular Plastics Traceability

Processes and data sharing approach for enabling circular packaging value networks



Document Summary

Document name	Circular Plastics Traceability
Date latest changes	May 2023
Document Version	1.0
Status	Approved
Document Description	This guideline describes how traceability in circular plastics can be facilitated by using GS1 standards for identification and data sharing. The focus is on data-driven traceability enabled by the description of the relevant EPCIS visibility events and the associated data attributes.

Contributors

Name	Organisation
Luca Simon	Arburg GmbH + Co KG
Steffen Kuhnigk	Brückner Group GmbH
Nicolas Becker	European EPC Competence Center GmbH (EECC)
Dr. Sebastian Schmittner	European EPC Competence Center GmbH (EECC)
Andreas Dirnberger	Erema Engineering Recycling Maschinen und Anlagen Ges.m.b.H.
Elena Berg	Institut für Kunststoffverarbeitung in Industrie und Handwerk an der Rheinisch-Westfälischen Technischen Hochschule Aachen e.V.
Maik Krüger	Kampf Schneid- und Wickeltechnik GmbH & Co. KG
Huafeng Zhao	Kautex Maschinenbau GmbH
Tim Rippinger	Kautex Textron GmbH & Co. KG
Dr. Benedikt Brenken	ProData GmbH
Alina Ott	Reifenhäuser GmbH & Co. KG
Ralf Wiechmann	Reifenhäuser Blown Film GmbH & Co. KG
Sarah Grede	GS1 Germany GmbH
Anna Klapper	GS1 Germany GmbH
Sabine Kläser	GS1 Germany GmbH
Agnes Peres	GS1 Germany GmbH
Dr. Ralph Tröger	GS1 Germany GmbH

Log of Changes

Release	Date of change	Changed by	Summary of change
1.0	29.08.2023	Sarah Grede, Dr. Ralph Tröger, Anna Klapper	Release/publication

Disclaimer

GS1® endeavours to avoid uncertainties in its intellectual property (IP) policy by requiring that all members of the working groups that are developing this standard, the Circular Plastics Traceability Guideline, grant all GS1 participants a free licence or a FRAND licence. Furthermore, we would like to point out that the implementation of one or more features of a standard may prejudice a patent or other intellectual property. Such patents or intellectual property rights fall outside of GS1's licensing obligation. The agreement to grant a licence according to the GS1 IP Policy does not apply to intellectual property rights or to the claims of third parties who have not been involved in the working groups. The greatest of care has been taken in compiling these documents and the GS1 standards contained therein. GS1, GS1 Germany and all third parties that were involved in the compilation of this document explicitly declare that they cannot be held liable in connection with this document, nor for any damages suffered by third parties, including direct and indirect damages, and for any loss of profits that arises in connection with the use of these standards. This document is subject to amendments at any time and may be adapted in light of new developments. The standards presented in this document may be adapted to new requirements – particularly legal requirements – at any time. This document may contain protected trademarks or logos that may not be reproduced by third parties without the permission of the holder of these rights.

GS1 Germany GmbH

It started with a beep.

1974 was the year that a barcode was scanned for the first time by a supermarket. This was the beginning of the automated check-out – and the first chapter in GS1’s success story. The machine-readable GS1 barcode, which also contains the GTIN, has since become the universal standard in the global exchange of goods. Six billion of these barcodes are scanned on products each and every day. The GS1 standards are the global language for efficient and secure business processes – a language that is spoken between different companies and across all continents. As part of a global network, we work with our customers and partners to develop market-driven and future-oriented solutions that have a direct impact on the success of their business. Today, two million companies from over 20 sectors worldwide use this language to uniquely identify their products, sites and assets, so that they can collect relevant data and share it with business partners within value-added networks. GS1 – The Global Language of Business.

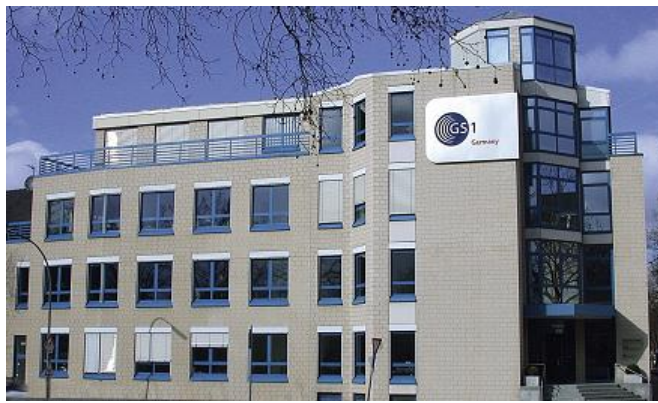


Table of Contents

1	Management Summary	10
2	Introduction	11
2.1	Legal Framework.....	11
2.2	As-Is Situation and Way Forward	13
3	Scope and Target Audience.....	13
3.1	Scope	14
3.2	Target Audience.....	14
4	GS1 Standards Relevant for Circular Plastics Traceability.....	15
4.1	Traceable Objects	16
4.1.1	Global Trade Item Number (GTIN)	16
4.1.2	Global Location Number (GLN)	16
4.2	GS1 Digital Link	17
4.3	EPCIS for Sharing Visibility Data	17
4.4	GS1 Core Business Vocabulary (CBV)	18
4.5	GS1 Web Vocabulary	18
5	Processes and Data-Sharing Approach for Enabling Circular Packaging Value Networks	18
5.1	Circular Packaging Value Networks	18
5.2	Business Process Flow	19
5.3	Data Attributes	24
5.4	Visibility Events Using EPCIS	30
5.4.1	Event 1 PlasticRawMaterialProducing	35
5.4.2	Event 2 ComponentProducing	39
5.4.3	Event 3 ComponentReshaping	44
5.4.4	Event 4 ComponentProcessing.....	45
5.4.5	Event 5 PackagingProducing.....	47
5.4.6	Event 6 WasteProcessing	48
5.5	Example.....	51
5.5.1	Pouch.....	53
5.5.2	Bottle.....	57
6	Links and References.....	62
6.1	Links and References: Circular Packaging.....	62
6.2	Links and References: GS1 Standards.....	63
7	Annex	64
A.1	Code values of recycling-relevant field names in EPCIS events.....	64
	Imprint	76

List of Figures and Tables

Figure 4-1: GS1 system of standards: Identify – Capture – Share	15
Figure 5-1: Circular packaging value network	19
Figure 5-2: BPMN business process flow chart	23
Table 5-3: Overview of recycling-relevant attributes relevant for circular packaging	29
Table 5-4.1: Visibility events based on recycling-relevant process steps	31
Table 5-4.2: EPCIS event type decision matrix.....	32
Figure 5-5.1: EPCIS events for circular plastics traceability.....	52
Figure 5-5.2: EPCIS events example: pouch	54
Figure 5-5.3: EPCIS events example: bottle	58

List of Abbreviations

Abbreviation	Definition
API	Application Programming Interface
BOPET	Biaxially-Oriented Polyethylene Terephthalate
BOPP	Biaxially Oriented Polypropylene
BPMN	Business Process Model and Notation
CEAP	EU Circular Economy Action Plan
CLP regulation	Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures
CBV	Core Business Vocabulary
CPP	Cast Polypropylene
GS1 DL	GS1 Digital Link
DPP	Digital Product Passport
EBAK	Ethylene-Butylacrylate Copolymers
ESPR	Ecodesign for Sustainable Products Regulation
EGD	European Green Deal
EPC	Electronic Product Code
EPS	Expandable and Expanded Polystyrene
EPCIS	Electronic Product Code Information Services
EPR	Extended Producer Responsibility
EVAC	Ethylene-Vinylacetate Copolymers
FMCG	Fast-Moving Consumer Goods
GCP	GS1 Company Prefix
GLN	Global Location Number
GPC	Global Product Classification
GSMP	GS1 Global Standards Management Process
GTIN	Global Trade Item Number
GTS	GS1 Global Traceability Standard
HDPE	High-Density Polyethylene
ID	Identification
ILMD	Instance/Lot Master Data

Abbreviation	Definition
JSON-LD	Serialisation for Linked Data based on JavaScript Object Notation
LDPE	Low-Density Polyethylene
LG TIN	Global Trade Item Number combined with a lot/batch number
LLDPE	Linear Low-Density Polyethylene
PA	Polyamide
PBT	Polybutylene Terephthalate
PCR/PIR	Post-Consumer Recycled / Post-Industrial Recycled
PE	Polyethylene
PET	Polyethylene Terephthalate
PET-A	Polyethylene Terephthalate – Amorphous
PET-C	Polyethylene Terephthalate – Crystalline
PET-G	Polyethylene Terephthalate – Glycol-modified
PHA	Polyhydroxyalkanoates
PIB	Polyisobutylene
PLA	Polylactic Acids
PO	Mixtures of PE and PP resins (polyolefins)
POS	Point Of Sale
PP	Polypropylene
PP-B	Polypropylene Block Copolymer
PP-R	Polypropylene Random Copolymer
PPWD	EU Packaging and Packaging Waste Directive 2018/852
PPWR	EU Packaging and Packaging Waste Regulation
PS	Polystyrene
PUR	Polyurethane
PVAL	Polyvinyl Alcohol (also abbreviated as PVOH or PVA)
PVC	Polyvinyl Chloride
PVDC	Polyvinylidene Di-Chloride
RFID	Radio Frequency Identification
RIBC	Rigid Intermediate Bulk Container
SG TIN	Global Trade Item Number combined with a serial number

Abbreviation	Definition
TPE	Thermoplastic Elastomer
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
URI	Uniform Resource Identifier
UTC	Universal Time Coordinated
VerpackG	German Packaging Act

1 Management Summary

While plastic packaging offers many benefits, such as protection and increased durability of products, it also leads to major environmental problems and plastic pollution. In European Union member states only 32.5 percent of the plastic produced is recycled, whereas 67.5 percent ends up in incineration or landfill¹. To promote high-quality recycling of plastic packaging, efforts by all stakeholders involved are needed – with the aim of generating new plastic packaging out of used packaging materials. Many companies want to take responsibility and are committed to ambitious goals through increasing the recyclability of packaging and the use of recycled materials. However, the availability of high-quality, application-oriented recyclates is still limited.

This GS1 Germany Guideline aims to specify processes and attributes to enable data-driven circular packaging value networks. A common data framework enables all stakeholders involved to act in a way that supports the circular economy, enabling data to be shared among all entities with the focus on resource efficiency and the consideration of a low carbon footprint as requested by the EU Circular Economy Action Plan (CEAP).

As, for instance, the production of plastic packing material entails dynamic and permanently changing usage of (partly recycled) inputs, the underlying business process steps are intended to be captured through EPCIS. The focus here is on collecting structured information through data-capturing points in machines used in the production and recycling processes of plastic packaging. This is a foundation of valuable primary life cycle data needed for subsequent business processes and trading partners. EPCIS, along with its accompanying data standard, the CBV, is GS1's core standard to enhance visibility in companies or value networks. In simple terms, it provides a common language to capture and share what are known as EPCIS events, providing organisations with the what, when, where, why and how of objects traversing through business processes.

Six EPCIS events were identified to generate transparency along the physical material flows of plastics packaging. The relevant attribute set aims to increase recyclate qualities and quantities through increased knowledge of the composition of recyclates and thus enable more efficient and application-oriented recycling, as well as tracking and tracing the quantity shares of recycled contents in plastics applications.

Ultimately, the guideline will provide guidance on the implementation of circular plastics traceability. In addition, it will help to identify needs for attributes to be standardised at the global level.

¹ European Parliament, Plastikmüll und Recycling in der EU: Zahlen und Fakten (2023)

2 Introduction

2.1 Legal Framework

Accelerating the transformation to a circular economy is one of the key priorities in the EU. The European Commission summarised this ambitious roadmap in 2019 within the framework of the European Green Deal (EGD).

In line with this ambition, the CEAP was published in March 2020. This action plan structures the measures and paves the way towards a transition from a linear to a circular economy. This includes a call to action in terms of mobilising data infrastructures in order to:

- track products and their material use
- track the journey of products, components and materials
- make recycled content in products measurable.

The implementation of these ambitious goals can only succeed on the basis of a fundamental change in value chain networks. Data-capturing and accessing points will support physical material flows. Here, a key instrument to provide transparency along the whole life cycle of products has been introduced with the Ecodesign for Sustainable Products Regulation (ESPR) published in March 2022: the Digital Product Passport (DPP). All focus sectors² covered by the regulation need to be linked to a relevant data set in the future that will lead to:

- extension of the lifespan of products
- resource-efficient usage
- recovery to enable a second life cycle.

Although packaging is not a focus sector for ESPR, processes and data sharing in circular packaging value networks require a similar approach. A unique identifier is needed in the process that can be unambiguously used in a cross-sectoral way among the multiple stakeholders. Product data needs to be shared in a standardised language. Transparency provides the possibility to increase the sustainability performance of products and packaging and to empower consumers in their purchasing decisions. According to the ESPR, one of the fundamental prerequisites is comprehensive interoperability based on open standards – at the technical, semantic and organisational level. Interoperability in the flow of goods and materials must be provided and the information exchange needed from product design through to the last step of dismantling the item and the reuse of its components or recycling must be enabled. A common data language will unlock an ecosystem of shared and decentralised responsibility for data, where each actor is responsible for providing, sharing and/or enriching product data when interacting with it.

In line with the EGD, the CEAP and the EU Plastics Strategy, in November 2022 the European Commission published a proposal for a Regulation of the European Parliament and of the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (PPWR). Within it, the requirements for the handling of packaging information by the economic operators are once again specified and tightened up:

From 2030, all plastic packaging must include a minimum percentage of recycled content by weight of:

- 30 percent for contact-sensitive packaging made from PET as the major component, 10 percent for contact-sensitive packaging made from plastic materials other than PET, except single-use plastic beverage bottles
- 30 percent for single-use plastic beverage bottles
- 35 percent for all other packaging.

² Packaging is not addressed as a specific product category in the ESPR

In 2040 the recycled content will increase to 50 percent for contact-sensitive plastic packaging, except single-use plastic beverage bottles, and 65 percent for single-use plastic beverage bottles and all other packaging.

In addition, all packaging should be recyclable from 2030 on. Furthermore, the PPWR states that ensuring packaging's traceability will help to identify non-compliant packaging by economic operators, who should therefore be required to keep the information on their transactions with regard to packaging information.

Moreover, the overall ban on certain plastic items according to Directive (EU) 2019/904 on Single-Use Plastics supports the European path towards more responsible production and consumption of plastic. It also requires that PET bottles should consist of at least 25 percent recycled material by 2025 and of at least 30 percent recycled material by 2030³.

When it comes to plastic packaging, the Extended Producer Responsibility (EPR) principle is another important building block in the handling of packaging volume, invoked by Directive 94/62/EC on Packaging and Packaging Waste by requiring member states to take necessary measures to ensure that systems are set up for the collection and recycling of packaging waste. EPR is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. EPR is typically understood to involve a shift in responsibility from governments or municipalities to producers as well as encouragement for producers to take environmental considerations into account during the design phases of product development. EPR seeks to achieve a reduction in the environmental impact of products, from production through to end-of-life. In this regard, incentives for sustainability are a key design parameter for optimal EPR. EPR schemes for packaging rely on a system of fees that are assigned to packaging based on material type (e.g., plastic, paper, metal) and weight. In this way, EPR enables the funding of the collection for recycling of packaging materials. Ecomodulation is an approach by which these fees are structured in line with environmental considerations and policy objectives. The ecomodulation of EPR fees is one important approach to create specific incentives.

The German Packaging Act (VerpackG) transposes Directive 94/62/EC on Packaging and Packaging Waste into German law. With regard to recycling, the German Packaging Act demands recycling quotas for the different packaging materials.

- At least 90 percent by mass of plastic shall be recycled. By 2022, 70 percent of this recovery rate must be ensured through mechanical recycling.
- From 2025, the Packaging Act also stipulates the reuse of recycled materials. Thus, PET single-use plastic beverage bottles must consist of at least 25 percent by mass recycled materials. The obligation to use recycled material in single-use plastic beverage bottles will be extended from 2030 to the effect that they must consist of at least 30 percent by mass recycled material, regardless of the polymer type⁴.
- Section 21 of the Packaging Act regulates the incentivised structure of participation fees promoting ecological design.
 - under section 21 (1) no. 1: the use of materials and material combinations that allow the highest percentage possible to be recycled, taking the practice of sorting and recovery into account, and
 - under section 21 (1) no. 2: the use of recyclates and renewable raw materials.

In general, the legal situation is quite volatile as there are ongoing discussions on different national and European levels. If national or European requirements change or become more specific, this GS1 Germany Implementation Guideline may need to be updated accordingly.

³ Possible to calculate as an average for all PET bottles placed on the market on the territory of that member state

⁴ Possible to calculate as an average for all PET bottles placed on the market on the territory of that member state

2.2 As-Is Situation and Way Forward

By 2050, the consumption of relevant materials⁵ will double, whereby waste generation is expected to increase by 70 percent⁶. Measures are needed in all industry sectors to improve resource efficiency and reduce waste. Global value chains are about to change, and product sustainability is becoming more relevant for all business partners. The reasons are twofold: on the one hand, this is triggered by society and its desire for more sustainable products. On the other hand, it is triggered by legislation on a European level such as the EU Green Deal and the Circular Economy Action Plan.

There are several resource-intensive sectors that need to transform from a linear to a circular economy. One central sector is packaging – especially plastic packaging. Plastic is an important material that is a central part of our economy and our everyday life. The benefits are manifold: in the field of packaging, the material contributes to product safety and thus enables the reduction of waste, especially food waste. However, the way plastic is currently produced, used and disposed of does not help to realise circular approaches. On the contrary, it often harms the environment, as plastic waste ends up in nature or is incinerated and is not recycled to be used in a second life cycle.

Plastic packaging often has a complex structure and is made of different materials. Currently, recycling-relevant information from plastics production processes is neither collected in a standardised way nor made available in a structured way. However, it is precisely this information basis that is needed, on the one hand to be able to fulfil legal requirements in the future and, on the other hand, to enable efficient recycling for the recovery of high-quality recyclates.

One important step towards more circularity in plastics value networks is to generate transparency along the existing physical material flows. A common data framework enables all stakeholders involved to act in the interests of the circular economy, enabling product data to be shared among all entities with the focus on resource efficiency and the consideration of a low carbon footprint. As the value network in the plastic packaging sector is very complex and many stakeholder groups are involved, cross-company collaboration is a prerequisite for the transition to a circular economy. In this context, the role of standardisation becomes even more important. Only if information is structured and standardised can it be shared between all stakeholders in the value network, allowing interactions and cooperations. Standardised data helps to optimise processes that extend the life cycle of materials and products. Using a common language is the only way to obtain the level of efficiency needed in the circular economy. And finally, because this data will mostly be processed by machines, interoperability of IT systems using a common language is crucial.

Still, creating transparency in the plastic packaging value network alone is not enough to tackle the multiple challenges of plastic pollution or climate change. It is crucial to consider the waste hierarchy. Thus, the foundation is minimising the amount of packaging, starting with the reduction of packaging material and introducing reusable packaging wherever possible. For packaging that cannot be avoided, recycling at end-of-life is a critical solution to enable circular value networks. Therefore, the design for recycling of plastic packaging is a prerequisite for all subsequent steps in the value networks and should be treated with the highest priority by all stakeholders involved. In addition, the performance of recycling systems – from collection and sorting to the sale of recycled materials – needs to improve globally. It is important to unlock potential for more efficient recycling in order to boost quantities of recyclates of suitable quality. All companies along the value chain have a responsibility to contribute to the success of these systems and objectives.

3 Scope and Target Audience

This GS1 Germany Guideline was developed on a national level, based on contributions from companies with national and international business activities. As such, it is a guideline that may be used beyond national borders.

It describes process steps in plastics production and lists recycling-relevant data attributes for data transfer. Recycling-relevant data attributes within the meaning of this guideline are those that have an impact on the generation of application-oriented recyclates or the traceability of recycled content in packaging compositions. Creating transparency with regard to these properties offers the

⁵ Such as biomass, fossil fuels, metals and minerals

⁶ Circular Economy Action Plan (2020)

opportunity to exploit the necessary potential for driving the circularity of packaging life cycles forward. It presents the foundation for a standardised data model for recycling-relevant data in the plastic packaging industry, which forms the starting point for circular processes and their operationalisation. For this approach, the GS1 data-sharing standard Electronic Product Code Information Service 2.0 (EPCIS2.0) and Core Business Vocabulary 2.0 (CBV2.0) are used for capturing and providing visibility data.

At the moment, the topic of circular plastic packaging is evolving in a very dynamic manner:

- **Within the European and national legal framework, further developments and updates of acts, directives and regulations are expected.**
- **There are many local and global industry-driven initiatives engaged with regard to the overall topic of the circular packaging value network. Potential outcomes, in particular when it comes to the use of GS1 standards, may have an impact on the approach described in this GS1 Germany Guideline.**
- **Identified standardisation gaps from this national development will be brought to the GS1 Global Standards Management Process (GSMP). This could result in new aspects, which should then in turn also be taken into account.**

This leads to the fact that this GS1 Germany Guideline needs to be regularly reviewed and, if necessary, updated.

3.1 Scope

The scope can be defined in three categories with the following descriptions:

1. Materials
 - plastic, also including paper and aluminium components.
 - especially thermoplastic materials, as these are particularly suitable for the further processing of recyclates, including composite materials.
2. Applications
 - packaging referred to the fast-moving consumer goods (FMCG) industry (e.g. cosmetics, food packaging).
3. Use cases

Identifying structured data attributes for:

- the general increase in recyclate qualities and quantities through increased knowledge of the composition of recyclates and thus enabling more efficient and application-oriented recycling.
- tracking and tracing the quantity shares of recycled contents in plastics applications.

Nevertheless, it is possible to also apply this approach to other industry applications, e.g. agricultural films, or further use cases such as the identification of basic data attributes for recyclability of packaging or the carbon footprint of packaging.

3.2 Target Audience

This guideline is relevant for all stakeholders involved in the plastic packaging life cycle. Particular focus is on the process steps that are enabled by equipment manufacturers, so the main target audience are machine manufacturers together with the users of this equipment, especially business partners from the plastics production and recycling process. The initial focus is on applications in the FMCG industry.

A common business language and structured data in the beginning of life cycles will also bring benefits to business partners in the later life cycle stages and provide the basis for scalability and avoidance of individual solutions, as well as contributing to legal compliance.

Within the circular economy roadmap, the general intention is to integrate the circular economy as an education and knowledge transfer topic. This guideline may support these efforts.

4 GS1 Standards Relevant for Circular Plastics Traceability

GS1 standards are the most widely used system of business standards in the world⁷. Using existing open standards for circularity purposes, too, will not only enable efficient technical management and oversight in the implementation of systems such as EPR schemes, but also support consumer empowerment through enhanced value chain transparency⁸.

GS1 standards are categorised into three dimensions: Identify, Capture and Share

1. GS1 ID keys enable organisations to assign standard identifiers to products, documents, physical locations and more. Because GS1 ID keys are globally unique, they can be shared between organisations, increasing supply chain visibility for trading partners. For instance, the Global Trade Item Number (GTIN) can be used by a company to uniquely **identify** all of its trade items.
2. These keys can be represented in data carriers, such as barcodes or EPC/RFID tags, to enable automatic data **capture**.
3. They may also be used in electronic communications, improving speed and accuracy when **sharing** master data, transaction data and visibility data.

Traceability of plastic packaging in a circular plastics value network is mostly enabled by using visibility data. In the present use case, recycling-relevant information is collected and made available at the batch level via machines in recycling and production processes. As a result of a dynamic production process, the properties of the respective outputs produced, such as raw materials, packaging components or final packaging, depend on the individual properties of their input materials at batch/lot level, which may vary. EPCIS and the Core Business Vocabulary are used to exchange such data.

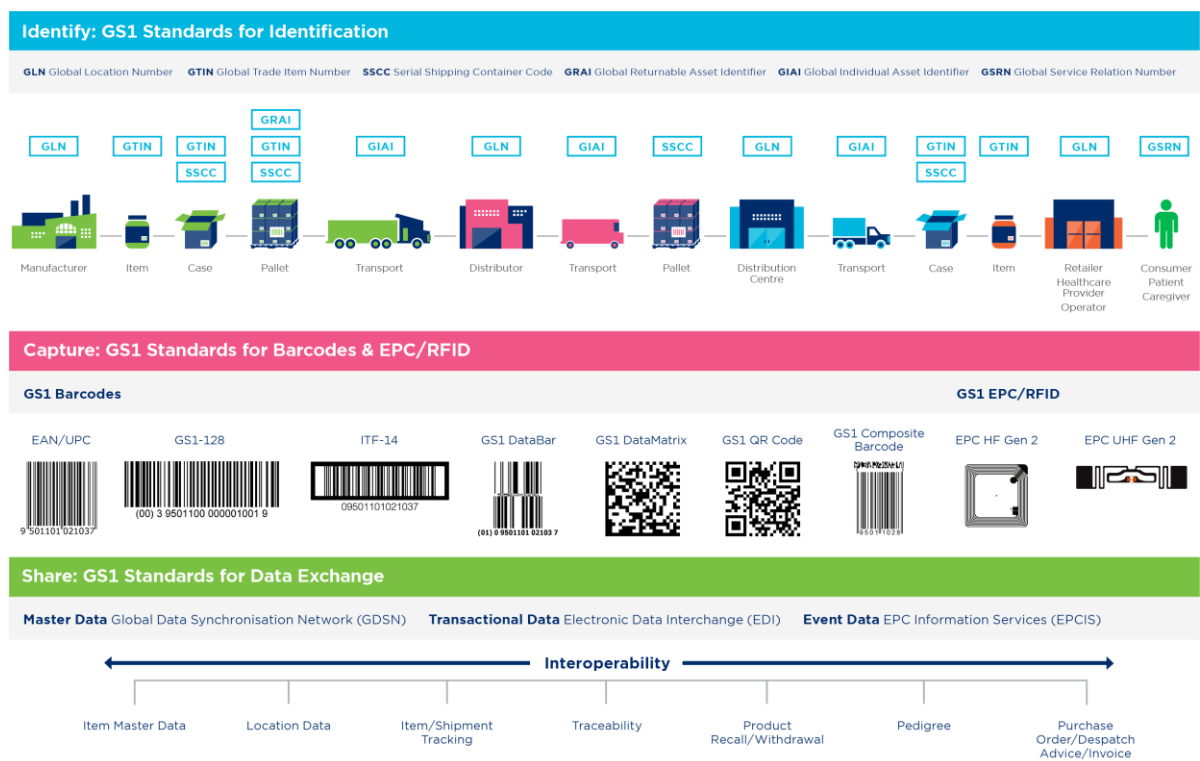


Figure 4-1: GS1 system of standards: Identify – Capture – Share

⁷ <https://www.gs1.org/>

⁸ Deloitte (2022), Impact of international, open standards on circularity in Europe, page 5

4.1 Traceable Objects

Every packaging or packaging component thereof and every input to a packaging or a packaging component during production is relevant for subsequent steps in the circular packaging value network. They are traceable objects according to the GS1 Global Traceability Standard (GTS) because their path through plastic packaging production needs to be determined and observed. The GTS lists all available identification keys for such traceable objects. In the context of circular plastic packaging, the GTIN is the most important ID key to be considered.

Traceability, i.e. the ability to trace the history, application or location of an object, such as a raw material or consumer packaging, is a vital requirement for improving resource efficiency and enabling circular plastics networks. Based on the GS1 system of standards, the GTS assists organisations and industries in the design and implementation of traceability systems. The GTS is intended to help organisations and industries to achieve global supply chain traceability by:

- providing a methodology for organisations to use when developing requirements for the design of traceability systems that fit their needs and objectives.
- serving as the foundational starting point for sector-specific, regional and local standards and guidelines.

The GTS is accessible at <https://www.gs1.org/standards/gs1-global-traceability-standard/current-standard>

4.1.1 Global Trade Item Number (GTIN)

GS1 defines trade items as products or services that are priced, ordered or invoiced at any point in the supply chain. The GTIN thus identifies types of services or products at any product level, e.g. consumer unit, inner packaging, case, pallet, etc. As a consequence, every consumer package and every hierarchy level of a product package is allocated its own GTIN. In addition, every packaging and packaging component of a finished product and every material that is needed to produce it, such as recycle or substrates, should be allocated their own GTINs as they are needed to populate EPCIS event messages and give unambiguous answers to the “what” dimension explained below. The GTIN rules and how to manage allocated GTINs are defined in the GS1 General Specifications and on <https://www.gs1.org/1/gtinrules/en/>.

With regard to the granularity of product identification, three levels need to be distinguished:

1. The GTIN itself refers to the class level and thus to a type of product, enabling it to be distinguished from different kinds of products. For a distinction within a class, the GTIN needs to be combined with additional attributes (key extensions).
2. The LGTIN combines the GTIN with a batch/lot number, limiting the number of traceable objects with the same GTIN to a smaller group of instances (for example, items produced in the same time period).
3. The SGTIN is a combination of GTIN plus serial number and is used for identifying a single instance. The number of traceable objects with the same ID is limited to one individual instance.

Due to dynamic processes in production and recycling, a lot of data in circular plastics production only applies to small groups of instances and the LGTIN is the appropriate level of granularity. This is why the EPCIS events in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** relate to LGTINs.

4.1.2 Global Location Number (GLN)

The Global Location Number (GLN) can be used to identify locations and parties, giving them complete flexibility to identify any type or level of location required. It provides a globally unique, standardised identifier that allows companies to answer the questions “who” and “where” within their own organisation and throughout the entire supply chain.

The GLN can be applied, for example, for the identification of

- A company as a legal entity

- Physical locations such as warehouses or dock doors,
- Physical sub-locations like machines within a warehouse

The Global Location Number allocation and management rules are available via this link: <https://www.gs1.org/1/glnrules//en/>.

Note: A GLN may be combined with a GLN extension. However, while a given GLN may be used to identify a party and separately to identify a location, a GLN extension component shall only be associated with the physical location. Besides this, a GLN extension component shall only be used internally by an organisation or through mutual agreement between partners to identify a sub-location on or within the location of the GLN identifying the physical location, such as an exact production line or machine.

4.2 GS1 Digital Link

The GS1 Digital Link standard makes it possible to express any GS1 identifier such as a GTIN or SGTIN as a web URI, thus making them directly resolvable through the web. On this basis, GS1 Keys can act as a gateway to human- or machine-readable facts and assertions made about them.

With regard to the recycling-relevant EPCIS messages described below for all object and location identifiers, GS1 Digital Link (DL) URIs should be used instead of EPC URIs/EPC Class URIs. You can find more information in the event design principles in chapter 5.4.

For example, a GTIN with a lot number represented in a GS1 Digital Link could look as follows: <https://id.example.com/01/04012345111118/10/LOT123>.

The GS1 Digital Link is accessible at <https://www.gs1.org/standards/gs1-digital-link>

4.3 EPCIS for Sharing Visibility Data

The goal of EPCIS is to enable disparate applications to create and share visibility data, both within and across enterprises.

EPCIS shares traceability data between trading partners regarding the physical movement and status of products in the supply chain.

As products travel from supplier to manufacturer, and then to distributor and retailer, and ultimately to the consumer, traceability data is generated each step of the way. EPCIS and its accompanying data standard, the Core Business Vocabulary, enable different applications to create and share event data, which is critical for interoperable traceability systems.

“Objects” in the context of EPCIS typically refer to physical objects that are identified either at a class (e.g. GTIN or LGTIN) or instance level (SGTIN) and which are handled in physical handling steps of an overall business process. Examples of such physical objects include trade items (products) or returnable assets, etc. EPCIS data consists of “visibility events,” each of which is the record of the completion of a specific business process step acting upon one or more objects.

Critical Tracking Events (CTEs) with Key Data Elements (KDEs) based on EPCIS and CBV provide all stakeholders with a shared view of the following:

- Who or which parties are involved?
- What is the product being produced?
- Where does a Transformation Event that included the product take place?
- When does a Transformation Event that included the product occur?
- Why is the product at that location at that time?
- What business process happens?
- What process step within the plastic packaging value network takes place?
- What was/is the condition of the product?

In chapter 5.5, the EPCIS approach is described by means of an example.

The EPCIS Standard is accessible at: <https://www.gs1.org/standards/epcis>

4.4 GS1 Core Business Vocabulary (CBV)

The GS1 Core Business Vocabulary (CBV) is a companion standard to EPCIS and specifies the structure of vocabularies and specific values for vocabulary elements in EPCIS events.

The vocabulary identifiers and definitions in this standard aim to ensure that all parties who exchange EPCIS data follow common syntax rules and have a common understanding of the semantic meaning of that data.

Since enabling circularity in plastic packaging requires EPCIS events to convey comprehensive data relevant for this area of application, this guideline specifies a number of domain-specific extension fields and code values (see chapter 5.3 and annex A.1). To adhere to the GS1 Architecture Principles (e.g. interoperability, forward-looking, non-duplication, and reuse of components) to the greatest extent possible, this guideline advocates leveraging the GS1 Web Vocabulary (see next paragraph) for all of the latter.

The CBV standard is accessible at <https://ref.gs1.org/guidelines/epcis-cbv/>.

4.5 GS1 Web Vocabulary

The GS1 Web Vocabulary (WebVoc) collects terms defined in various GS1 standards and data systems and made available for general use following Linked Data principles. It is an external extension to schema.org that allows further details about products, assets and other entities to be expressed using Linked Data technology.

In the context of this guideline, the advantage of using the WebVoc is that all fields and values are defined at the global level and come with online-accessible definitions. Moreover, all WebVoc classes, attributes and code values are web URIs, which facilitates both integration as well as scalability. In addition, every EPCIS extension field needs to be a valid URI anyway, which is inherently covered by using the WebVoc.

WebVoc terms and their definitions come from existing GS1 standards (e.g. GDSN). With regard to this guideline, the field names (i.e. classes or attributes) are defined in the EPCIS event specification (see chapter 5.4), while the code values are listed in Annex 7.

Some of the domain-specific extension fields and code values are not currently available in the WebVoc. This will be subject to the future global standardisation work (GSMP). After passing through the GSMP, this guideline will be updated accordingly.

The WebVoc is accessible at <https://www.gs1.org/gs1-web-vocabulary>.

5 Processes and Data-Sharing Approach for Enabling Circular Packaging Value Networks

With EPCIS as a global open standard it is possible to process data and visibility events for the plastic packaging life cycle in one common business language. According to the GS1 Guideline for the definition of EPCIS events, the following chapters encompass different steps in order to document the respective visibility events in a Visibility Data Matrix.

The link to the GS1 Guideline is available here: <https://www.gs1.org/standards/epcis-and-cbv-implementation-guideline>

5.1 Circular Packaging Value Networks

Figure 5.1 shows the complex interactions of different stakeholders taking part in the production as well as the use and recycling of plastic packaging. They have different roles, responsibilities and obligations in order to achieve and support circular processes for plastic packaging. Efficient and circular processes between all stakeholders involved cannot happen unless data is structured and

shared through a common business language. This guideline focuses specifically on the process steps in the circular value network that are enabled by machines and, through this, the possibility to capture and access recycling-relevant data – marked in green in figure 5-1 below. Depending on the process step, this can be any production facility, from plastic film machines, injection or blow-moulding machines to converting, printing and filling machines.

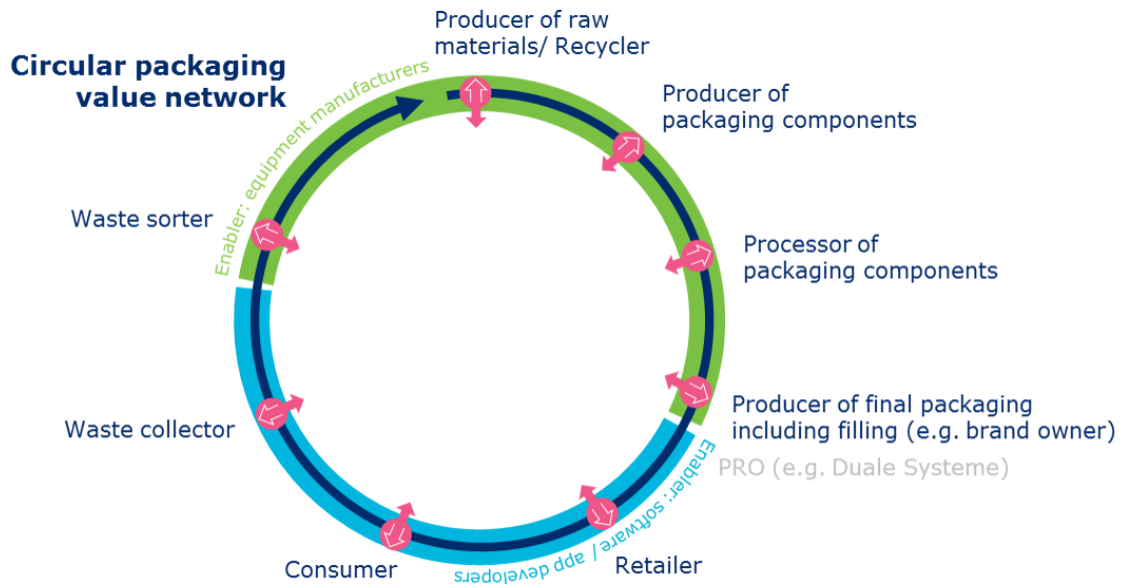


Figure 5-1: Circular packaging value network

The use of recyclates in packaging is an important element for the distributors of consumer products and their packaging to prove compliance with PPWR. In addition, many business partners make significant commitments, including the use of more recycled content. Therefore, on the one hand, solutions are required that enable tracking and tracing of recyclate contents in packaging, in order to have a better overview, for example, of the extent to which the packaging consists of recyclate that comes from post-consumer waste. On the other hand, there needs to be an increase in quantities of application-oriented recyclate qualities that allow widespread use in different packaging types and their pre-products. This requires data flows along the recycling and production processes that might also encourage compliance with design-for-recycling requirements. With this transparency, the transformation towards a circular economy for packaging will be a realistic scenario and the ambitious goals of all business partners will be achievable.

The EPCIS-based approach presented in this guideline provides a possibility for packaging producers and packaging distributors to precisely trace the recyclate quantities per production batch. The end-to-end visibility enables transparency regarding the origin of recyclates (e.g. post-consumer waste) and informs stakeholders in the production process of packaging whether, for example, the recyclate is suitable for further processing.

5.2 Business Process Flow

In order to identify the recycling-relevant data, the physical material flow of the production process steps needs to be defined first. Fifteen relevant process steps were identified, describing the whole plastic packaging life cycle.

In the following, each activity as shown in figure 5-2 is further characterised. In every process step, the stakeholders of the circular packaging value network and the actors involved are named and information is provided regarding the purpose of the process step and its input and output. Several

of the steps mentioned below can also be repeated during the complete process. Depending on the individual application, these can also take place in different sequences.

Production of raw materials

1. Production of plastic granules

The process flow begins with the production of plastic granules (raw material) as the first step. In the circular packaging value network as shown in 5.1, the stakeholders of this step are the producers of raw materials. Producers of plastic granules are the actors involved in producing monomers based on crude oil. After polymerisation and, if necessary, compounding, the plastic is further processed into plastic granules. In this way, with the input of crude-oil-based materials, bio-based materials and PCR/PIR (for recycling), plastic granules are obtained.

Production of components and substrates for packaging

The next production step (injection moulding, blow moulding and/or substrate production) is relevant for the producer of components and substrates for packaging. There are three different possible variants:

2. Injection moulding

Injection moulding is the procedure of melting and homogenising plastic granules. The plastic mass is injected into the mould and the packaging component is ejected from the mould thereafter. The output of these processed plastic granules is injection-moulded (components for) packaging, such as cups, caps, lids or preforms for blow moulding.

3. Blow moulding

Blow moulding is a process for forming hollow plastic parts⁹. Blow moulding may consist of forming preforms or melting and homogenising plastic granules into parison and inflating it into different shapes of hollow parts. The output is blow-moulded (components for) packaging, such as bottles or jerrycans.

4. Substrate production

The substrate producer melts plastic granules (input) and casts them into a web or tube form. This process step is the substrate production. Substrates may also be stretched during this step. A web product on film reel is gained as the output.

Processing of components and substrates for packaging

The following process steps can be summarised as processing of components and substrates for packaging.

5. Stretching

The stretching step needs substrates, e.g. the web product on film reel, as an input. The stretching processes film reels, which are usually stretched in a continuous manner in the machine direction to improve the properties.

6. Slitting

The slitting step needs substrates, e.g. the web product on film reel, as an input. By slitting, the film reels are typically divided into various individual reels. The output is the slitted substrate, which also remains a web product on film reel.

7. Laminating

For laminating, two web products on film reel are needed as an input. They can be made of polymer, paper, aluminium or laminates. Additionally, adhesives are indispensable. The two web products are glued together with these adhesives in between (2-ply laminate). In a further step, another film may be glued onto the finished laminate (3-ply laminate). The output is the laminated substrate.

8. Printing/coating

⁹ There are three main types of blow moulding: extrusion blow moulding, injection blow moulding and stretch blow moulding

In the printing/coating step, it is necessary to differentiate between the printing/coating of the injection- or blow-moulded packaging (components) and the printing/coating of web products.

The former requires injection- or blow-moulded (components for) packaging (made out of polymer, paper or laminates), printing inks and coatings as the input. Printing inks or coatings are applied in several layers to an injection- or blow-moulded component for packaging.

The latter needs web products on film reel (made out of polymer, paper or laminates) as the input. In this case, too, printing inks and coatings are additionally required. They are then applied in several layers to the web-shaped product.

In both process steps, the respective layer can be applied over the entire surface or only partially, as is typical for printing. The outputs are printed/coated injection- or blow-moulded (components for) packaging as well as printed substrates, e.g. labels, in-mould labels, and substrates for pouches or trays.

Producer of final packaging and filling of goods

9. Packaging production with filling

What follows is a more complex process step which finalises the packaging. The packaging production with filling is important for the packaging producer and the filler, which can be the same actor. One or more packaging components are composed into one item of packaging. Depending on the product, the components are further processed. The packaging is then filled with the product before the packaging is sealed. The input needed is therefore on the one hand the packaging components, consisting of the produced/printed/coated/laminated/slitted/stretched substrate, the injection-moulded packaging components and the blow-moulded packaging components. The combination of these can be in different constellations, e.g. a bottle with a label and a cap, a substrate for a pouch with a zipper or a substrate for a tray with lidding substrates and the final lid. On the other hand, the product content (e.g. food or non-food) is needed as an input. The fact that adhesives, paper, aluminium or printing inks may be added also needs to be considered. The output is the final packaging, including the (consumer) product.

Selling and using of consumer product

The following steps are relevant for completing the process but not relevant for the recycling process. They will be described below but not considered in the further guideline.

10. Selling

After the filling, the product is forwarded to the point of sale (POS). The final product is sold at the POS or online. The input and output are therefore the consumer product.

This step is described explicitly because in many European countries (e.g. Germany), according to the national EPR schemes, any party responsible for placing packaged products on the market must pay a fee for the recycling of their packaging waste. This fee depends on the type of packaging material and packaging weight. According to country-specific conditions, the law thereby creates an economic incentive for companies to use recyclable packaging and for the use of recycled content.

11. Using and collecting

After the product is sold, the following process step is using and collecting. The consumer product as the input is used and plastic packaging is collected separately according to the country-specific collecting schemes. Hence, the output is plastic packaging waste.

Sorting and recycling of plastic packaging

The three final steps can at the same time be seen as the beginning of the plastic life cycle in a circular economy.

12. Sorting

The plastic packaging waste, the input in this step, arrives at the sorting plant. It is then further separated by different characteristics and subsequently sorted into different streams. Afterwards, the sorted waste is pressed into bales to facilitate further transport from the sorting plant to the recycling plant. These pressed bales of plastic are the output.

13. Recycling processing

In order to recycle the pressed bales of plastic, different further processing steps are required, such as debaling, additional sorting, cutting into uniform size, washing at different temperatures or in several stages, sink-float sorting, drying, colour sorting or wind sifting. The aim is to produce a uniform product, e.g. washed film flake, as an input for the next step. In order to recycle the pressed bales of plastic, different further processing steps are required.

14. Recycling extrusion

To convert the flakes into processable plastic granules (recyclate), they are remelted in extruders. Additives or virgin material can be added in here. Unwanted components (e.g. contaminations) can be removed by melt filtration, degassing or even post-treatment of the granules. The resulting recyclate can now be used as an input material for the plastic raw material production or directly for production of plastic articles, either purely or as an addition to virgin material.

In circular processes, the two steps of recycling extrusion and the production of raw materials can be equated.

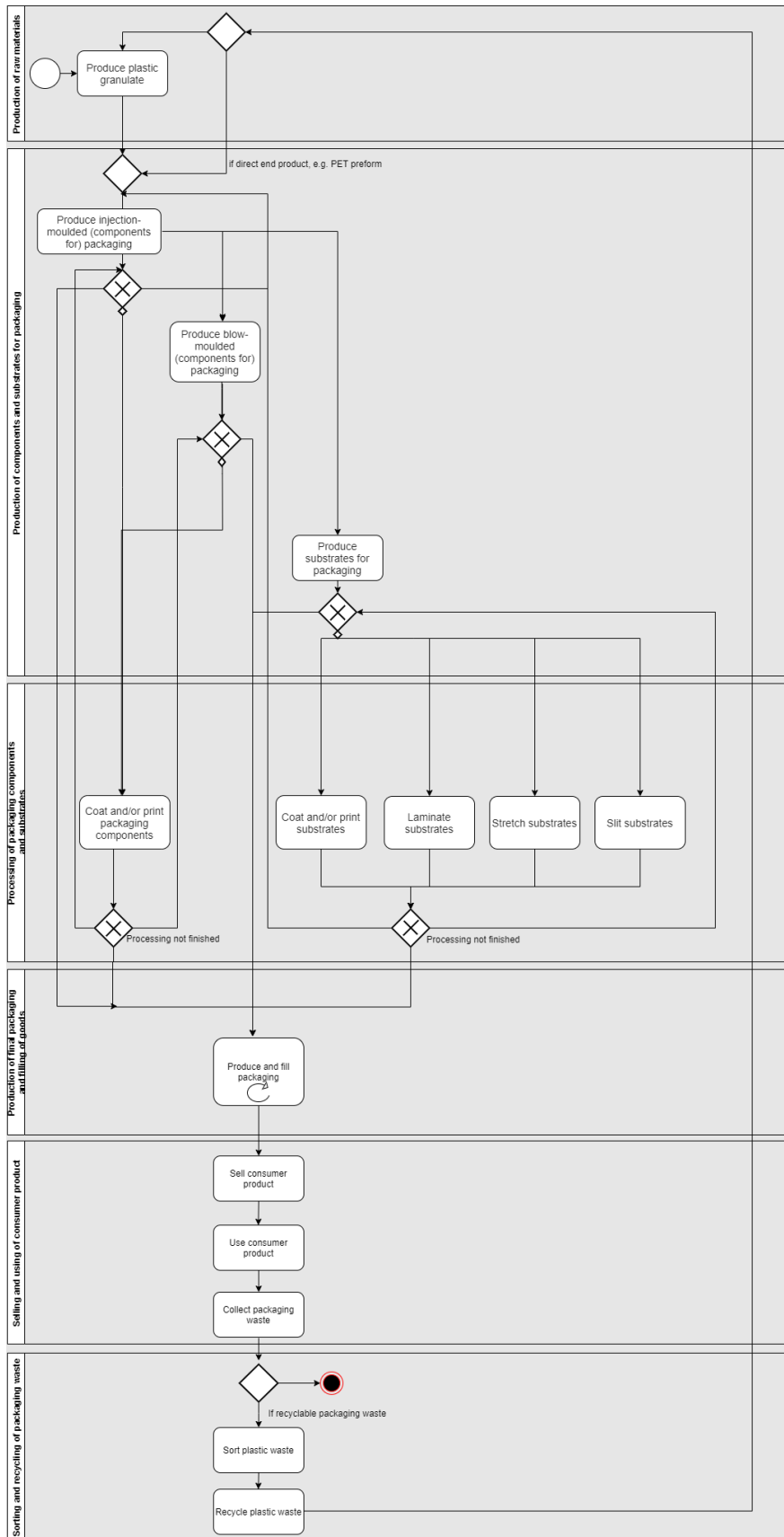


Figure 5-2: BPMN business process flow chart

5.3 Data Attributes

Table 5.2 lists the relevant attributes for circular plastics networks. The code lists and values for every attribute with the data type "code list" can be found in annex 7. Table A2.1 in annex A.2 lists attributes needed for the technical implementation of the EPCIS events for circular plastics traceability.

At the time of writing this guideline, many of these data elements and code lists and values are not yet standardised. To accommodate this situation, these data elements are defined under the "example" namespace in the relevant EPCIS events. They will be subject to future development work within the GSMP. This process may have an impact on their names and definitions. Once these data elements are available as GS1 Linked Data, they will replace all elements in the "example" namespace.

No.	Field name	What?	Why?	Who?	Data type
1.	Additives	Description of the recycling-relevant additives processed in packaging (components)	Additives can have an impact on the quality of recycled material. Business partners need to know of their existence, e.g. for determining the quality of the second-life packaging.	Sorting operators and recyclers can use this information to exclude materials in high-quality sorting fractions (negative sorting).	Code list
2.	Adhesives	Adhesive group and percentage of adhesive processed in packaging (components)	There are adhesives that are more compatible with the polymer in recycling and others that reduce the polymer quality – relevant for sorting and further processing.	Sorting operators and recyclers can use this information to manage the composition of the sorting fractions according to the compatibility of their inputs.	Code list
3.	Application range	Information about the application the material is produced for and can be used for after recycling. Refers to the highest percentage contained in packaging (components)	The application range is a relevant property to derive/determine the appropriate production method(s): indicates for which applications the recycle from the packaging can be used (e.g. applicable for injection moulding or substrate production) – therefore relevant for sorting and further processing.	Sorting operators, recyclers and packaging (component) producers can use this information to be able to process the materials with the respective properties correctly.	Code list

No.	Field name	What?	Why?	Who?	Data type
4.	Biodegradability	Indication whether material is 100 percent biodegradable. We assume that packaging is either completely biodegradable or not at all.	Biodegradable materials can be used as a separate fraction – e.g. for industrial composting or recycling. It is not useful to have such materials mixed into other fractions.	<p>Sorting operators can use this information to manage their sorting fractions.</p> <p>In case of negative sorting: the sorting operator could use this information to exclude biodegradable materials in high-quality sorting fractions.</p> <p>In case of positive sorting: the sorting operator could use this information to sort a fraction with 100 percent biodegradable materials that can be used for industrial composting or possibly also for recycling.</p>	Boolean
5.	Coatings	Coating group and percentage of each coating applied in packaging (components)	There are coatings that are more compatible with the polymer in recycling and others that reduce the polymer quality – relevant for sorting and further processing.	Sorting operators and recyclers can use this information to manage the composition of the sorting fractions according to the compatibility of their inputs.	Code list
6.	Colour of basic material	Information about the colour category of the basic material (excluding printing colours)	The colour of the basic material has an impact on the recycle quality – relevant for sorting and further processing. For example, transparent recyclates are of higher quality than coloured ones. Dark ones cannot be used to make light materials in the second life cycle and are therefore of lower value.	Sorting operators, recyclers and packaging (component) producers can use this information to influence the quality of recycle for both procedural and monetary purposes.	Code list
7.	Colour of printing	Information about the colour category of the printing of the packaging	<p>The colour of the printing has an impact on the recycle quality – relevant for sorting and further processing. For example, transparent recyclates are of higher quality than coloured ones. Dark ones cannot be used to make light materials in the second life cycle and are therefore of lower value.</p> <p>If deinking is applied, there is no need to consider this attribute for the recycle quality.</p>	Sorting operators, recyclers and packaging (component) producers can use this information to influence the quality of recycle for both procedural and monetary purposes.	Code list

No.	Field name	What?	Why?	Who?	Data type
8.	Component type	Information about the type of packaging component	This information is important to know which components an item of final packaging consists of – especially during the production of packaging in upstream processes.	Packaging (component) producers can use this information for proper description of packaging production processes.	Code list
9.	Content of packaging	Information about the content of the packaging	The content of the packaging is crucial for further processing of the polymers. The information on whether packaging materials were used for food products is a prerequisite for food-grade recyclates. Food packaging materials in recycling processes are of higher value due to the fact that this evidence brings more possibilities for use in new applications in the second life cycle. Furthermore, the content of the packaging has an impact on the migration of polymers as, for example, detergents would have an impact on the smell of the recyclates, which is again crucial for new applications.	Sorting operators and recyclers can use this information to generate high-quality sorting fractions according to the content of the packaging, e.g. food.	Code list
10.	Density	Information about the density of the material	The mean value of density of packaging ingredients determines the level of separability in the sorting process, which is therefore relevant for sorting and further processing.	Sorting operators, recyclers and packaging (component) producers can use this information to be able to process the materials with the respective properties correctly.	Numeric
11.	Fillers	Description and percentage of fillers processed in packaging (components)	Fillers have an impact on the quality of recycled material – relevant for sorting and further processing.	Sorting operators and recyclers can use this information to manage the composition of the sorting fractions according to the compatibility of their inputs.	Code list

No.	Field name	What?	Why?	Who?	Data type
12.	Food approval	Indication of whether there is any official food approval for all materials and additives processed in the respective production step	Needed to support the guidelines on submission of a dossier for safety evaluation by the EFSA ¹⁰ of a recycling process to produce recycled plastic intended to be used for manufacture of materials in contact with food. All ingredient materials of such packaging must be approved for food products.	Packaging producers can use this information to conform to regulations for food-contact materials but potentially also for other FMCG product categories. It could potentially also serve as a prerequisite piece of information in the future – used by recyclers – to ensure that recycle is food-approved for the second life cycle.	Boolean
13.	Inks	Description of the recycling-relevant inks processed in packaging (components)	There are inks that are more compatible with the polymer in recycling and others that reduce the polymer quality – relevant for sorting and further processing.	Sorting operators and recyclers can use this information to manage the composition of the sorting fractions according to the compatibility of their inputs.	Code list
14.	Input material origin	Indication from which origin and to what percentage the input material of the raw material is obtained – differentiated according to the origin of the material and the type of recycling process	The input material origin is needed to allow full traceability regarding the share of recycled content in packaging (components) used in order to comply with the proposal for the EU PPWR. This will oblige economic operators to provide information about the recycled content in packaging. Differentiation between the origin of post-consumer recycle (PCR) and post-industrial recycle (PIR) according to DIN EN ISO 14021:2016 is key for national EPR reporting purposes. It might also be relevant in the future to know whether the input material is bio-based.	Brand owners and retailers need this information for ecomodulation, EPR declaration, consumer communication and further reporting purposes.	Code list
15.	Length weight	Length weight is the weight of a substrate in proportion to its (individual) length	The length weight depends on the dimensions and density of a component. It is needed for reporting and calculating dimensions in the process of packaging (components).	Packaging (component) producers need this unit of measurement to be able to calculate proportions of materials in packaging (components). Among other things, this property is crucial for calculating the proportions of recycled content during the respective process steps.	Numeric

¹⁰ European Food Safety Authority

No.	Field name	What?	Why?	Who?	Data type
16.	Package type	The dominant means used to transport, store, handle or display the trade item as defined by the data source. This package type is not used to describe any manufacturing process. The expression trade item here relates to the good that is filled in the packaging ¹¹ .	This information is used to describe the final geometry of the packaging.	Brand owners and retailers can use this information for further usage in recyclability tools and for internal reporting.	Code list
17.	Packaging ingredient details	Description and percentage of all polymer types, fillers, inks, coatings, paper and adhesives each packaging (component) consists of	The composition of packaging materials is crucial in all steps of the packaging life cycle, as it influences the recyclability of packaging (components) and the potential for usage in the next life cycle. The percentage makes it possible to report the actual share of relevant materials – including with regard to regulations, e.g. §21 VerpackG.	Sorting operators and recyclers can use this information to manage the composition of the sorting fractions according to the packaging ingredient details. Packaging producers, retailers and brand owners can use this information to report on the actual share of relevant materials.	Code list
18.	Polymer types	Description and percentage of each polymer the raw material and packaging (components) consist of	The proportions of polymer types are important for mechanical recycling. Depending on the polymer groups a raw material consists of, it is allocated to the applicable fraction (PE, PET, etc.).	Sorting operators , recyclers and packaging (component) producers can use this information to influence the quality of recyclate for both procedural and monetary purposes.	Code list
19.	Print type	Information about the type of printing the packaging (component) is printed with	Depending on the print type, some inks can be removed from the packaging using specific recycling processes – known as the deinking process.	Sorting operators and recyclers can use this information for proper sorting and deinking if applicable and necessary.	Code list
20.	Separability code	Information on which components of the packaging are separable and how they can be separated from the main packaging component	Some packaging components can be separated from the main component (component with the highest weight) before the recycling process takes place. For example, a paper label can be separated from a PET tray and lid before the PET tray is recycled. In this case, the tray and lid can be considered as “polymer only” (without paper). This must be reflected in the digital data.	Sorters and recyclers need this attribute for proper sorting and recycling.	Code list

¹¹ According to the GDSN description in the FMCG target market profile for Germany

No.	Field name	What?	Why?	Who?	Data type
21.	Surface weight	The surface weight of the substrate is the weight per area unit, e.g. per square metre	The surface weight depends on the dimensions and density of a component. It is needed for reporting and calculating dimensions in the process of packaging (components).	Packaging (component) producers need this unit of measurement to be able to calculate proportions of materials in packaging (components). Among other things, this property is crucial for calculating the proportions of recycled content during the respective process steps.	Numeric
22.	Unit weight	Unit weight is the weight of a (packaging) component	The unit weight is needed for reporting and calculating dimensions in the process of packaging (component) production.	Packaging (component) producers need this unit of measurement to be able to calculate proportions of materials in packaging (components). Packaging producers need it to calculate the ratio between the packaging and its filling. Among other things, this property is crucial for calculating the proportions of recycled content during the respective process steps.	Numeric
23.	Waste class	The type and mixture the sorted waste consists of	The composition of sorted waste influences the quality of the recycled material and is therefore an important piece of information for further processing.	Recyclers and packaging (component) producers can use this information for proper usage of recyclate.	Code list
24.	Waste origin	Indication from which waste stream the material comes. It relates to input material origin but only to recycled material and is to some extent more granular with regard to the waste origin.	The waste origin has an impact on the quality and value of the recycled materials. This information is needed for further processing in recycling and for usage in a second life cycle.	Sorting operators, recyclers and packaging (component) producers can use this information to influence the quality of recyclate for both procedural and monetary purposes.	Code list

Table 5-3: Overview of recycling-relevant attributes relevant for circular packaging

5.4 Visibility Events Using EPCIS

Based on the recycling-relevant process steps described in 5.2, this chapter specifies the (in total six) EPCIS events needed to enable circular plastics traceability. For the sake of a wide application basis, some process steps were subsumed under one event.

Event Dimensions

The content of each event can be structured according to four dimensions:

- **What:** Identifies the physical or digital objects that were involved in the event. Trade items are identified using a GTIN, a GTIN plus batch/lot number, or a GTIN plus serial number.
- **When:** The date and time when the event took place, and the local time zone in effect
- **Where:** Captures where the event physically took place and/or where things are following the event. EPCIS events allow for two location types, readPoint and businessLocation. The readPoint is the location where the event took place. With regards to circular plastics production, the GLN or GLN with extension are typically applied.
- **Why:** Describes the business context in which the event took place. It can include any combination of data elements describing, for example, the business step or the disposition.
- **How:** Used to express conditional information about an object or physical location, e.g. as captured by sensors¹².

Their relation to the recycling-relevant process steps is presented in the following table.

	#	Business Process Steps	Data Attributes	#	EPCIS Visibility Events
Circular Packaging Value Network	1	Production of plastic granules (raw material)	Packaging ingredient details Food approval Colour of basic material Application range Additive details Biodegradability Input material origin Density	1	Plastic raw material producing
	2	Injection moulding	Packaging ingredient details Food approval Colour of basic material Application range Additive details Biodegradability Input material origin Density Surface weight Length weight Unit weight	2	Component producing
	3	Blow moulding			
	4	Substrate production			
	5	Stretching	Surface weight Length weight Unit weight	3	Component reshaping
	6	Slitting			
	7	Laminating	Packaging ingredient details Food approval Colour of printing Biodegradability	4	Component processing

¹² Not applicable for this area of application

	8	Printing/coating of injection- or blow-moulded packaging (components)	Print type Density Surface weight Length weight Unit weight		
	9	Printing/coating of web products			
Production final packaging and filling	10	Packaging production with filling	Content of packaging Package type Component type code Separability code Unit weight	5	Packaging producing
Selling and using of consumer product	11	Selling	No data		No EPCIS Visibility Events
	12	Using and collecting			
Sorting and recycling of plastic packaging	13	Sorting ¹³	Waste class details Waste origin Biodegradability Colour of basic material	6	Waste processing
	14	Recycling processing	No data		No EPCIS Visibility Events
	15	Recycling extrusion	See #1	1	Plastic raw material producing

Table 5-4.1: Visibility events based on recycling-relevant process steps

General Remarks on EPCIS Event Modelling

The modelling of the EPCIS events is based on the following GS1 standards:

- EPCIS Standard, release 2.0
- Core Business Vocabulary (CBV) Standard, release 2.0
- GS1 Digital Link Standard: URI Syntax, release 1.2
- GS1 Web Vocabulary, release 1.5.1

Event Design Principles

For the six business process steps, the EPCIS event types `TransformationEvent` and `ObjectEvent` should be applied as follows:

Event	TransformationEvent	ObjectEvent
-------	---------------------	-------------

¹³ The selected attributes in the business process step sorting reflect the current state of the art of existing industrial sorting technologies. Of course, potential future technologies might bring further possibilities for the granularity level in the sorting process. In this context, attributes from the production process might bring added value for the generation of high-quality recycle.

Plastic Raw Material Producing	x (If at least one input has a GS1 Key)	x (If none of the inputs have a GS1 Key)
Component Producing	x (If at least one input has a GS1 Key)	x (If none of the inputs have a GS1 Key)
Component Reshaping	x	
Component Processing	x	
Packaging Producing	x	
Waste Processing	x (If at least one input has a GS1 Key)	x (If none of the inputs have a GS1 Key)

Table 5-4.2: EPCIS event type decision matrix

- The reason for allowing two EPCIS event types in three of the above cases is based on the fact that "... a TransformationEvent SHALL include at least one input (i.e., at least one of inputEPCList and inputQuantityList are non-empty) AND at least one output (...)" (EPCIS 2.0, section 7.4.5). This cannot be guaranteed for plastic raw material producing, component producing and waste processing. The remaining events, however, always come with at least one input with a GS1 Key and can therefore be consistently captured through TransformationEvents.
- If applicable, Circular Plastics Traceability EPCIS Events comprise a PackagingIngredientDetails extension field which allows for flexibility to capture the respective inputs (identified via standardised code values) if there are no GTINs/LGTINs available to identify the input(s).
- To enable trading partners, for example, to properly calculate the share of materials from a specific origin, PackagingIngredientDetails comprises the actual portion of a given ingredient in the output product. The actual portion for the identifiers present in the inputQuantityList is indicated in InputQuantityListShares. The portions of both PackagingIngredientDetails and InputQuantityListShares must jointly add up to 100 percent (Note that a weight-based approach was not deemed viable as, for example, weights are sometimes difficult to determine, would include wastage, and do not reflect the practical reality of how machines are configured in this domain.)
- Important: If present, all extension fields (e.g. biodegradability, foodApproval, ColourOfBasicMaterial, applicationRange, AdditiveDetails, InputMaterialOrigin, etc.) apart from InputQuantityShares apply to the materials contained in the PackagingIngredientDetails field, i.e. not to the output product. Hence, if there is no PackagingIngredientDetails element, there must be no event-level extensions and the relevant information can be obtained via preceding EPCIS events. The only exceptions to this rule are as follows:
 - Extension fields conveyed in the Instance/Lot Master Data (ILMD) section. In this case, the corresponding attributes apply to the materials populating the outputQuantityList.
 - The ComponentDetails field as part of the Packaging Producing event. This container accommodates information about the respective components the final packaging consists of (e.g., bottle, label and cap).
- The same logic as described in the previous bullet point (regarding PackagingIngredientDetails) also holds true for the Waste Producing event, though in this

case, the container element accommodating inputs that have no GTIN/LGTIN (anymore) is named `WasteClassDetails`.

GS1 Digital Link URIs and Resolvers

For all object and location identifiers, GS1 Digital Link (DL) URIs should be used instead of EPC URIs/EPC Class URIs. This forward-looking approach enables on-demand queries, for example, and simplifies adoption as GS1 DL URIs do not require knowledge of the length of the GS1 Company Prefix (GCP).

Illustration:

- **GTIN + Batch/Lot:** `https://id.example.com/01/04012345999952/10/Lot123`
(instead of `urn:epc:class:lgtin:4012345.099995`)
- **GTIN:** `https://id.example.com/01/04012345999952`
(instead of `urn:epc:idpat:sgtin:4012345.99995.*`)
- **GLN:** `https://id.example.com/414/4012345000115`
(instead of `urn:epc:id:sgln:4012345.00011.0`)
- **GLN + GLN Extension:** `https://id.example.com/414/4012345000115/254/12`
(instead of `urn:epc:id:sgln:4012345.00011.12`)
- If an own namespace for constructing GS1 Digital Link URIs is not available or desired, implementations should use the canonical GS1 Digital Link URI syntax, i.e. `id.gs1.org`.
- Users with a GS1 Company Prefix licensed from GS1 Germany may also use `id.gs1.de` and populate the GS1 Germany Resolver with corresponding entries for their identifiers. For these entries, requests via `id.gs1.org` are instantly forwarded to GS1 Germany's Resolver and resolved appropriately.
- It is at the discretion of a data provider if and at which level of granularity GTIN- or GLN-based data is shared through resolvers. For instance, if an organisation does not want to publicly share the meaning of a given GLN + extension populating the `readPoint` (which identifies a specific machine, for example), it may:
 - only publish an entry at GLN level. As resolvers have a built-in "walk-up-the-tree" feature, clients are still provided with the meaning of the GLN (which typically identifies the site) or
 - publish entries for GLN + Extension, but request an accessing client to authenticate/authorise itself before returning the respective data.

Note Regarding GTIN-/GLN-Level Master Data

Most product- and location-related data in this area of application is dynamic. For example, the actual composition of products can change with a new product batch/lot. Nevertheless, a couple of GTIN/GLN-level master data (e.g. name of a product/location) must be available, e.g. for better data processing.

As there is only a limited set of master/location required, the GS1 Registry Platform (designed as a thin registry for GS1 Keys) may already be sufficient to address this need. In order to work with the above-mentioned solution approach (i.e. applying GS1 Digital Link URIs), a GS1 Key licensee only needs to insert an entry into:

- the GS1 Registry Platform and
- a GS1 Digital Link Resolver Service (with the endpoint of the GS1 Registry Platform's publicly accessible API)

If more master data attributes are required, an implementation may provide the latter via, e.g.

- Synchronisation in advance (for instance, via GDSN)
- Query on demand (for instance, via GS1 Digital Link master data query)

Web URIs for Vocabulary Elements

- For all web-URI-based classes, properties or values that are not yet standardised, we use the `example.com` namespace.
- Note that URIs under the `example.com` namespace cannot be resolved, i.e. will not return useful data when invoking a web request.
- Implementations of GS1 Germany's recommendation "Processes and data sharing approach for circular plastics" are strongly advised to apply GS1 standard URI values once the latter become available following GS1's GSMP process.
- Once this has been accomplished, definitions of vocabulary elements will become available online. Taking the example of describing the colour, we are then able to precisely indicate which colour code list we apply (see <https://gs1.org/voc/ColourCodeListCode>) and which colour code value (see <https://gs1.org/voc/colourCodeValue>) is expected.

JSON/JSON-LD

As of EPCIS 2.0, EPCIS events can be expressed in either XML or JSON/JSON-LD. For new implementations, GS1 Germany recommends JSON/JSON-LD, whose advantages include for example:

- easier processing
- more familiar to current generation of software developers
- less overhead (more lightweight)
- supporting linked data

Nevertheless, there is no obligation to use JSON/JSON-LD if there are good reasons to do otherwise. This guideline does not stipulate the data format.

Advice as to EPCIS Event Standard Fields

Event ID

- As of EPCIS 2.0, a REST interface was introduced to capture/query EPCIS events. In this context, populating the `eventID` field is recommended as each EPCIS event can be considered an individual resource which may be queried. This may be accomplished by the EPCIS capture server.
- For this purpose, applying the EPCIS Event Hash ID (calculated from an EPCIS event's intrinsic values), introduced as of CBV 2.0, is recommended. See CBV 2.0, section 8.9.2 EPCIS Event Hash ID for further details.

Transformation ID

- In case transformational processes last for longer periods, EPCIS allows to link several Transformation Events by applying a `TransformationID`.
- A pragmatic way to construct a `TransformationID` is the GLN-based URN as specified in the CBV standard. After a specified prefix (`urn:epcglobal:cbv:xform:`), the latter consists of an organisation's party GLN, followed by a unique string such as a simple incremented counter variable. See CBV 2.0, section 8.8.3 GLN-based Identifier for Legacy Transformation Identifiers for further details.

5.4.1 *Event 1 PlasticRawMaterialProducing*

Case 1: no identifiable inputs (i.e. not any input having a GS1 key)

Dim	Data Element ¹⁴	Content	Example	Occurrence	Comment
	Event_Type	ObjectEvent	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.OZ	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	quantityList			0..1	
	_quantityElement			1..n	Container element indicating the quantity and unit
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/L0T123	1	
	__quantity	Decimal value	12.5	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	The GLN (AI 414) identifies the production site. The optional GLN extension (AI 254) may identify the exact production line/machine.
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	action	ADD	See content	1	
	example:PackagingIngredientDetails			0..1	Container element comprising list of one or more dictionaries
	_example:typeCode	Packaging ingredient code value	example:PE	1	Examples of packaging ingredients: polymers, adhesives, coatings, fillers, papers

¹⁴ Whenever a field name is prefixed with one or more underscore characters (“_”), this field name is a child element of a preceding one. Example: The parent field of “__epcClass” is “_quantityElement”, which in turn is the child of “quantityList”.

Dim	Data Element ¹⁴	Content	Example	Occurance	Comment
	<code>_example:value</code>	Float value	62.0	1	A floating-point numeric value that is qualified by the corresponding measurement unit code, jointly indicating the portion of the specified ingredient
	<code>_example:unitCode</code>	UN/CEFACT Rec 20 Unit Code	P1	1	Limited to dimensionless concentration unit codes, e.g. percent or part per million
	<code>example:foodApproval</code>	Boolean (true or false)	true	0..1	true if yes, false otherwise
	<code>example:ColourOfBasicMaterial</code>			0..1	
	<code>_example:colourCodeValue</code>	Colour code value	example:TRANSPARENT_BL	1	
	<code>_example:colourCodeListCode</code>	Colour code list	example:ColourCodeList-CIRCULAR_PLASTICS	1	
	<code>example:applicationRange</code>	Application area code value	example:PE1	0..1	
	<code>example:AdditiveDetails</code>			0..1	Container element comprising list of one or more dictionaries
	<code>_example:additiveLevelOfContainment</code>	Additive Level of containment code value	example:LevelOfContainmentCode-CONTAINS	1	
	<code>_example:additiveCodeValue</code>	Additive code value	example:MB_AF, example:MB_AS	1	
	<code>example:biodegradability</code>	Boolean	false	0..1	true if yes, false otherwise
	<code>example:InputMaterialOrigin</code>			0..1	Container element comprising list of one or more dictionaries
	<code>_example:typeCode</code>	Input origin code value	example:PIR_C, example:PIR_M	0..1	Examples of Input origin: PIR chemical, PCR mechanical

Dim	Data Element ¹⁴	Content	Example	Occurance	Comment
	_example:value	Float value	29.0	1	A floating-point numeric value that is qualified by the corresponding measurement unit code, jointly indicating the portion of e.g. Post Consumer Recyclate from mechanical procedure
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:density			0..1	
	_example:value	Double value	0.98	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	23	0..1	MUST be indicated if available

Case 2: at least one identifiable input with a GS1 key

Dim	Data Element	Content	Example	Occurance	Comment
	Event Type	TransformationEvent	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			0..1	MUST be non-empty if there is no TransformationID
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	25.2	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
	outputQuantityList			0..1	SHOULD contain only one quantityElement unless all ILM attributes are identical for all output quantities.
	_quantityElement			1..n	See above

Dim	Data Element	Content	Example	Occurrence	Comment
	__epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/04012345222227/10/LOT456	1	
	__quantity	Decimal value	12.5	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	transformationID	TransformationID	urn:epcglobal:cbv:xform:0614141000005:123	0..1	
	example:InputQuantityShares			0..1	Container element comprising list of one or more dictionaries
	_example:quantity	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	_example:value	Float value	18.2	1	A floating-point numeric value that is qualified by the corresponding measurement unit code, jointly indicating the portion of the specified input quantity
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:PackagingIngredientDetails			0..1	See above
	_example:typeCode	Packaging ingredient code value	example:PE	1	See above
	_example:value	Float value	62.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:foodApproval	Boolean (true or false)	true	0..1	See above
	example:ColourOfBasicMaterial			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_BL	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR_PLASTICS	1	

Dim	Data Element	Content	Example	Occurrence	Comment
	example:applicationRange	Application area code value	example:PE1	0..1	
	example:AdditiveDetails			0..1	See above
	_example:additiveLevelOfContainment	Additive Level of containment code value	example:LevelOfContainmentCode-CONTAINS	1	
	_example:additiveCodeValue	Additive code value	example:MB_AF, example:MB_AS	1	
	example:biodegradability	Boolean	false	0..1	See above
	example:InputMaterialOrigin			0..1	See above
	_example:typeCode	Input origin code value	example:PIR_C, example:PIR_M	0..1	See above
	_example:value	Float value	29.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:density			0..1	
	_example:value	Double value	0.98	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	23	0..1	MUST be indicated if available

5.4.2 **Event 2 ComponentProducing**

Component producing includes the process steps blow moulding, injection moulding and substrate production.

Case 1: no identifiable inputs (i.e. not any input having a GS1 key)

Dim	Data Element	Content	Example	Occurrence	Comment
	Event Type	ObjectEvent	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	quantityList			0..1	
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	12.05	0..1	

Dim	Data Element	Content	Example	Occurance	Comment
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	action	ADD	See content	1	
	ilmd			0..1	See above
	_example:density			0..1	
	__example:value	Double value	0.98	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	23	0..1	MUST be indicated if available
	_example:surfaceWeight			0..1	Mutually exclusive to example:lengthWeight and example:unitWeight
	__example:value	Double value	02.02	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	25	1	
	_example:lengthWeight			0..1	Mutually exclusive to example:surfaceWeight and example:unitWeight
	__example:value	Double value	280	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GF	1	
	_example:unitWeight			0..1	Mutually exclusive to example:surfaceWeight and example:lengthWeight
	__example:value	Double value	12.04	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GRM	1	
	example:PackagingIngredientDetails			0..1	See above
	_example:typeCode	Packaging ingredient code value	example:PE	1	See above
	_example:value	Float value	62.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:foodApproval	Boolean (true or false)	true	0..1	See above

Dim	Data Element	Content	Example	Occurance	Comment
	example:ColourOfBasicMaterial			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_BL	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR_PLASTICS	1	
	example:applicationRange	Application area code value	example:PE1	0..1	
	example:AdditiveDetails			0..1	See above
	_example:additiveLevelOfContainment	Additive Level of containment code value	example:LevelOfContainmentCode-CONTAINS	1	
	_example:additiveCodeValue	Additive code value	example:MB_AF , example:MB_AS	1	
	example:biodegradability	Boolean	false	0..1	See above
	example:InputMaterialOrigin			0..1	See above
	_example:typeCode	Input origin code value	example:PIR_C, example:PIR_M	0..1	See above
	_example:value	Float value	29.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above

Case 2: at least one identifiable input with a GS1 key

Dim	Data Element	Content	Example	Occurance	Comment
	Event Type	Transformation Event	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.OZ	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			1	
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	12,5	0..1	

Dim	Data Element	Content	Example	Occurance	Comment
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
	outputQuantityList			1	See above
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/04012345222227/10/LOT456	1	
	__quantity	Decimal value	25,2	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	MTR	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	ilmd			0..1	Container element comprising lot-level master data
	__example:density			0..1	
	__example:value	Double value	0.98	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	23	0..1	MUST be indicated if available
	__example:surfaceWeight			0..1	Mutually exclusive to example:lengthWeight and example:unitWeight
	__example:value	Double value	2,2	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	25	1	
	__example:lengthWeight			0..1	Mutually exclusive to example:surfaceWeight and example:unitWeight
	__example:value	Double value	280	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GF	1	
	__example:unitWeight			0..1	Mutually exclusive to example:surfaceWeight and example:lengthWeight
	__example:value	Double value	12	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GRM	1	
	example:InputQuantityShares			0..1	See above

Dim	Data Element	Content	Example	Occurance	Comment
	_example:quantity	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	_example:value	Float value	18.02	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	Limited to dimensionless concentration unit codes, e.g. percent or part per million
	example:PackagingIngredientDetails			0..1	See above
	_example:typeCode	Packaging ingredient code value	example:PE	1	See above
	_example:value	Float value	62.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:foodApproval	Boolean (true or false)	true	0..1	See above
	example:ColourOfBasicMaterial			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_BL	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR_PLASTICS	1	
	example:applicationRange	Application area code value	example:PE1	0..1	
	example:AdditiveDetails			0..1	See above
	_example:additiveLevelOfContainment	Additive Level of containment code value	example:LevelOfContainmentCode-CONTAINS	1	
	_example:additiveCodeValue	Additive code value	example:MB_AF, example:MB_AS	1	
	example:biodegradability	Boolean	false	0..1	See above
	example:InputMaterialOrigin			0..1	See above
	_example:typeCode	Input origin code value	example:PIR_C, example:PIR_M	0..1	See above
	_example:value	Float value	29.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above

5.4.3 Event 3 ComponentReshaping

Component reshaping includes the process steps slitting and stretching.

Dim	Data Element	Content	Example	Occurrence	Comment
	Event Type	Transformation Event	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.OZ	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			1	
	_quantityElement			1..n	See above
	_epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	_quantity	Decimal value	22.08	0..1	
	_uom	UN/CEFACT Rec 20 Unit Code	MTR	0..1	
	outputQuantityList			1	See above
	_quantityElement			1..n	See above
	_epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/04012345222227/10/LOT456	1	
	_quantity	Decimal value	25.02	0..1	
	_uom	UN/CEFACT Rec 20 Unit Code	MTR	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	ilmd			0..1	See above
	_example:surfaceWeight			0..1	See above
	_example:value	Double value	02,02	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	25	1	
	_example:lengthWeight			0..1	See above
	_example:value	Double value	280	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	GF	1	
	_example:unitWeight			0..1	See above

Dim	Data Element	Content	Example	Occurance	Comment
	__example:value	Double value	12.04	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GRM	1	

5.4.4 Event 4 ComponentProcessing

Component processing includes the process steps laminating, printing and coating.

Dim	Data Element	Content	Example	Occurance	Comment
	Event Type	Transformation Event	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			1	
	__quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	12.02	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	MTR	0..1	
	outputQuantityList			1	See above
	__quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/04012345222227/10/LOT456	1	
	__quantity	Decimal value	25.02	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	MTR	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	example:InputQuantityShares			0..1	See above

Dim	Data Element	Content	Example	Occurrence	Comment
	_example:quantity	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	_example:value	Float value	18.02	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:PackagingIngredientDetails			0..1	See above
	_example:typeCode	Packaging ingredient code value	example:PE	1	See above
	_example:value	Float value	62.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:foodApproval	Boolean (true or false)	true	0..1	See above
	example:ColourOfPrinting			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_NC	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR_PLASTICS_PRINTING	1	
	example:biodegradability	Boolean	false	0..1	See above
	example:printType	Print type code value	example:SURFACE_PRINT	1	
	example:density			0..1	
	_example:value	Double value	0.98	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	23	0..1	MUST be indicated if available
	example:surfaceWeight			0..1	See above
	_example:value	Double value	02.02	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	25	1	
	example:lengthWeight			0..1	See above
	_example:value	Double value	280	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	GF	1	
	example:unitWeight			0..1	See above
	_example:value	Double value	12.04	1	
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	GRM	1	

5.4.5 *Event 5 PackagingProducing*

Dim	Data Element	Content	Example	Occurance	Comment
	Event Type	Transformation Event	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			1	
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	12. Mai	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
	outputQuantityList			1	See above
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/0401234522227/10/LOT456	1	
	__quantity	Decimal value	120	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	See comment	0..1	Very likely, the number of produced packagings is captured in this step, expressed through an integer in the quantity field. In these cases, the uom field can be omitted.
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	ilmd			0..1	See above
	_example:contentOfPackaging	Content of packaging code	example:FOOD	0..1	
	_example:packageType	Package type code value	example:STR	0..1	
	example:ComponentDetails			0..1	Container element comprising list of one or more dictionaries

Dim	Data Element	Content	Example	Occurrence	Comment
	_example:inputQuantity	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	_example:componentTypeCode	Component type code value	example:LABEL	1	
	_example:separabilityCode	Removable Separability code value	example:NOT_REMOVABLE	1	
	_example:unitWeight			0..1	See above
	__example:value	Double value	12.04	1	
	__example:unitCode	UN/CEFACT Rec 20 Unit Code	GRM	1	

5.4.6 Event 6 WasteProcessing

Case 1: no identifiable inputs (i.e. not any input having a GS1 key)

Dim	Data Element	Content	Example	Occurrence	Comment
	Event Type	ObjectEvent	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	quantityList			0..1	
	__quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/04012345111118/10/LOT123	1	
	__quantity	Decimal value	12.05	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating _class_instance (CBV)	See content	1	
Other	action	ADD	See content	1	
	example:WasteClassDetails			0..1	See above

Dim	Data Element	Content	Example	Occurrence	Comment
	_example:typeCode	Waste class type code value	example:PE	1	
	_example:value	Float value	32.0	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:wasteOrigin	Waste origin code value	example:PCR_MIX_COL	0..1	(PCR_MIX_COL...PCR from mixed collection)
	example:biodegradability	Boolean	false	0..1	See above
	example:ColourOfBasicMaterial			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_BL	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR-PLASTICS	1	

Case 2: at least one identifiable input with a GS1 key

Dim	Data Element	Content	Example	Occurrence	Comment
	Event Type	TransformationEvent	See content	1	
	eventID	EPCIS Event Hash ID	ni:///sha-256;9fa4(...)5f33?ver=CBV2.0	0..1	
When	eventTime	Timestamp of event	2022-04-28T11:30:00.0Z	1	
	eventTimeZoneOffset	UTC time offset	+01:00	1	
What	inputQuantityList			0..1	See above
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/0401234511118/10/LOT123	1	
	__quantity	Decimal value	12.05	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	
	outputQuantityList			0..1	See above
	_quantityElement			1..n	See above
	__epcClass	GS1 Digital Link URI (GTIN + Batch/Lot)	https://id.example.com/01/0401234522227/10/LOT456	1	
	__quantity	Decimal value	50.6	0..1	
	__uom	UN/CEFACT Rec 20 Unit Code	KGM	0..1	

Dim	Data Element	Content	Example	Occurrence	Comment
Where	readPoint	GS1 Digital Link URI (GLN + optional GLN extension)	https://id.example.com/414/4012345000115/254/12	1	See above
Why	bizStep	commissioning (CBV) or creating_class_instance (CBV)	See content	1	
Other	transformationID	TransformationID	urn:epcglobal:cbv:xform:0614141000005:123	0..1	
	example:InputQuantityShares			0..1	See above
	_example:quantity	GS1 Digital Link URI (GTIN or GTIN + Batch/Lot)	https://id.example.com/01/0401234511118/10/LOT123	1	
	_example:value	Float value	18.02	1	See above
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:WasteClassDetails			0..1	Container element comprising list of one or more dictionaries
	_example:typeCode	Waste class type code value	example:PPE	1	
	_example:value	Float value	32.0	1	A floating-point numeric value that is qualified by the corresponding measurement unit code, jointly indicating the portion of the specified waste
	_example:unitCode	UN/CEFACT Rec 20 Unit Code	P1	1	See above
	example:wasteOrigin	Waste origin code value	example:PCR_MIX_COL	0..1	
	example:biodegradability	Boolean	false	0..1	See above
	example:ColourOfBasicMaterial			0..1	
	_example:colourCodeValue	Colour code value	example:TRANSPARENT_BL	1	
	_example:colourCodeListCode	Colour code list	example:ColourCodeList-CIRCULAR-PLASTICS	1	

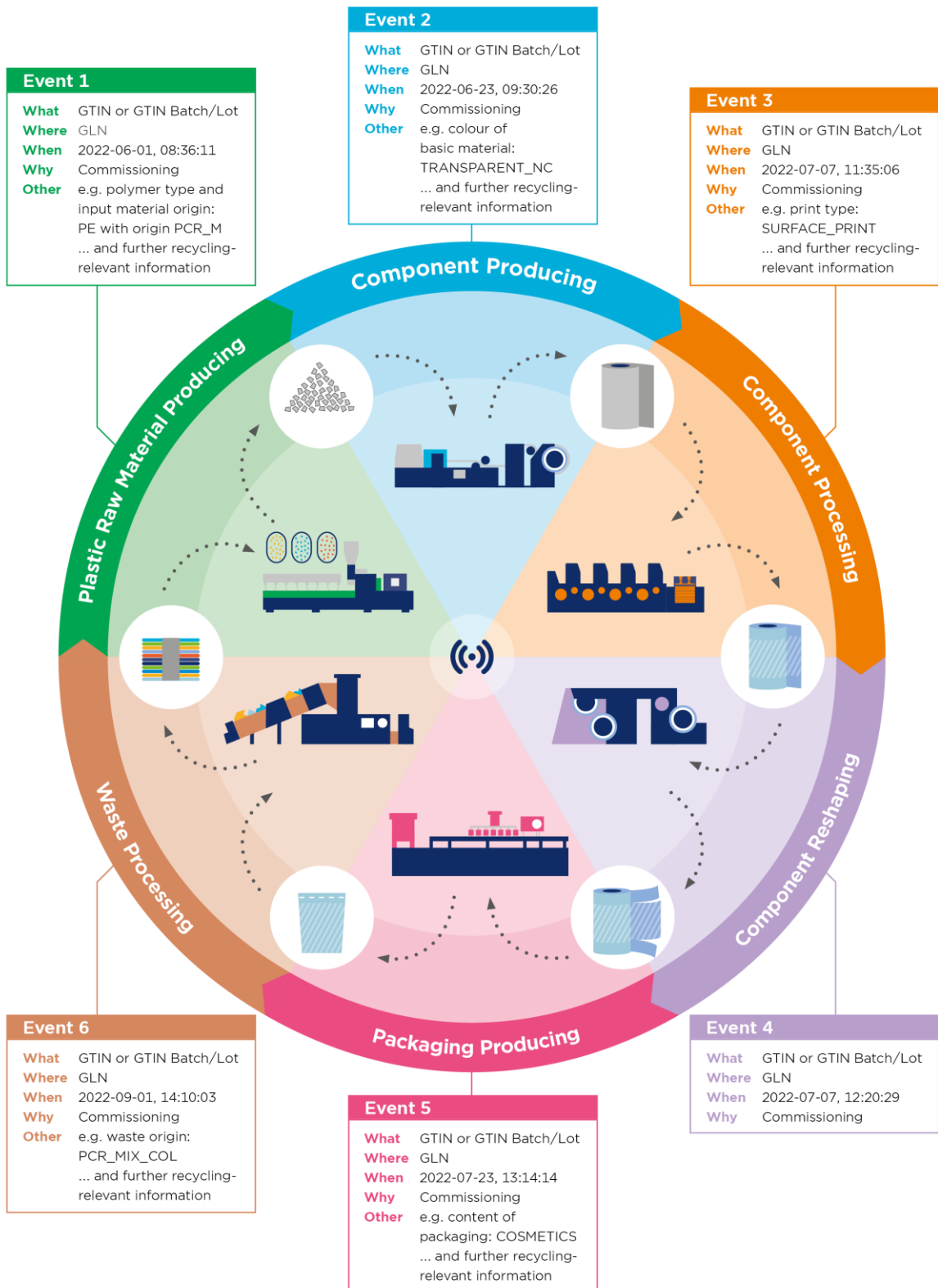
5.5 Example

In an ideal world with fully closed-loop systems, there will be consistent input from an earlier process step which is passed through along the life cycles of packaging. Here, in every recycling-relevant business step an EPCIS Transformation Event helps to show a concrete identifiable input and output relation between material flows and thus data flows. A Transformation Event provides the optimal standardised structure to transfer lot-level information, for example, for sustainability purposes such as actual recycled content. In practice, there are still not only identifiable inputs in circular plastics value networks. That is the reason why Object Events provide an alternative option. If there is no identifiable input such as a GTIN or LGTIN, an ObjectEvent is to be used.

To be able to better understand the added value of EPCIS in the context of plastic production, in the following section two practical examples are intended to provide an overview. The proposed best practices only show the ideal situation based on Transformation Events. This shows that EPCIS enables end-to-end visibility for recycling-relevant data and its continuous documentation.

The single steps can also be seen in figure 5-3. Event 6 has been left out of the example for the sake of simplification. The two examples focus on five questions that have been posed as a scope for this GS1 Germany guideline:

1. To what extent (percentage) does final packaging consist of recycled content?
2. Where does this share of recycled content originate from (e.g. recovered from post-consumer plastic waste)?
3. Which additives does a given packaging (component) contain?
4. What is the colour of a packaging component's basic material?
5. Which material(s) and/or ingredient(s) does a given packaging consist of?



GTIN Batch/Lot (Global Trade Item Number): used for identifying all kinds of inputs and outputs - typically in conjunction with batch/lot level, e.g. packaging components

GLN (Global Location Number): used for identifying the location, e.g. production facility

Figure 5-5.1: EPCIS events for circular plastics traceability

5.5.1 Pouch

For illustration purposes, this section takes a pouch as an example.

In this case, a pouch consists of two different films – film 1 and film 2 – and a spout. So, the possible production steps and EPCIS events in the example could be:

1. Production of recycled material for film 1 (EVENT: PlasticRawMaterialProducing)
2. Production of film 1 (EVENT: ComponentProducing)
3. Slitting of film 1 (EVENT: ComponentReshaping)
4. Printing of film 1 (EVENT: ComponentProcessing)
5. Production of virgin material for film 2 (EVENT: PlasticRawMaterialProducing)
6. Production of film 2 (EVENT: ComponentProducing)
7. Laminating of film 1 and 2 (EVENT: ComponentProcessing)
8. Slitting of the laminated film (EVENT: ComponentReshaping)
9. Production of recycled material for the spout (EVENT: PlasticRawMaterialProducing)
10. Production of the spout (EVENT: ComponentProducing)
11. Production of the final packaging consisting of spout and a laminated film (EVENT: PackagingProducing)

These EPCIS events in relation to the process can be pictured as follows:

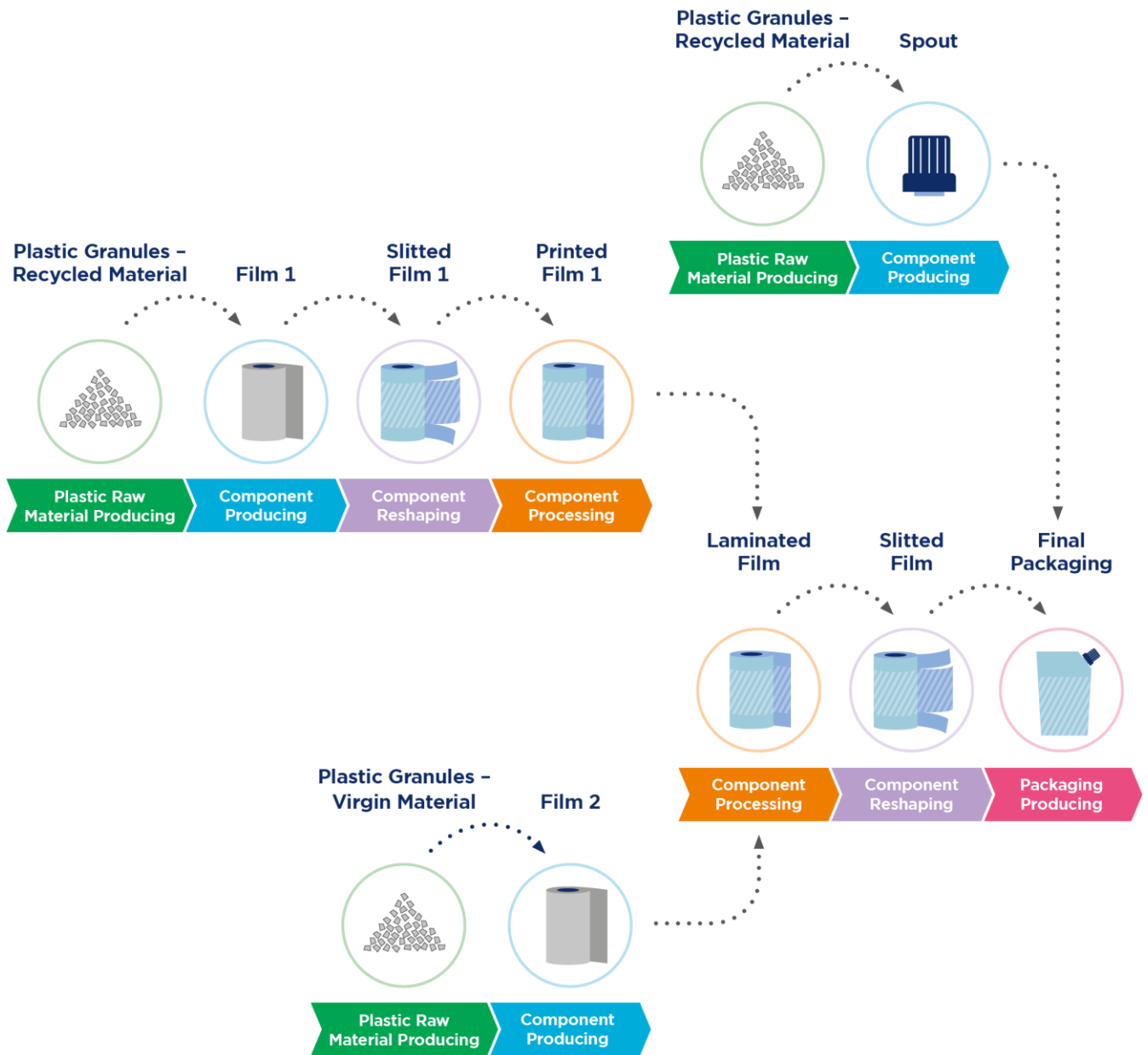


Figure 5-5.2: EPCIS events example: pouch

As can be seen in the above figure, the EPCIS events are not only captured once. Depending on the process, the same EPCIS events can occur several times.

For instance, for producing film 1, a **ComponentProducing Event** is needed. In this case, it is assumed that there exists at least one identifiable input and, as described in the beginning of this section, a Transformation Event is used. With this, the data from the previous event "RawMaterialProducing" can be advanced and further used to guarantee the detailed composition of input materials, e.g. recycled content of the raw material. This will be used in the end of the section to calculate the recycled content of the final packaging.

First, an EPCIS indicates the Event Type and, if applicable, an Event ID:

Dim	Data Element	Content
	Event Type	TransformationEvent
	eventID	ni:///sha-256;9fa42e8bf64e1cfe152d582a248646ce0ad2b0c6826c7e8ed95442a7a1545f33?ver=CBV2.0

Next, the visibility data matrix illustrates the “What” dimension. In this case, it accommodates the quantities of the respective input and output. Thereby, the input originates from the previous event “RawMaterialProducing”.

Dim	Data Element	Content
What	inputQuantityList	
	_epcClass	https://id.example.com/01/04012345111118/10/LOT123
	_quantity	300
	_uom	KGM
	outputQuantityList	
	_epcClass	https://id.example.com/01/04012345222227/10/LOT456
	_quantity	2000
	_uom	MTR

The next two segments of the visibility matrix capture the “When” (when the event occurred) and “Where” (where the event took place).

Dim	Data Element	Content
When	eventTime	2023-01-26T11:00:00.0Z
	eventTimeZoneOffset	+00:00
Where	readPoint	https://id.example.com/414/4012345000115

The EPCIS event also comprises the business process step of the event. As a new identifier comes into existence in this case, the value is set to “commissioning”.

Dim	Data Element	Content
Why	bizStep	commissioning

Extension fields convey additional recycling-relevant information. If the latter is part of the Instance-/Lot Master Data (ILMD) section, it pertains to the outputs. Otherwise, it relates to the materials that are added in this process step.

Dim	Data Element	Content
Other (extension)	ilmd	
Other (extension)	example:InputQuantityShares	
	_example:quantity	https://id.example.com/01/04012345111118/10/LOT123
	_example:value	51
	_example:unitCode	P1
	example:PackagingIngredientDetails	
	_example:typeCode	PE-LD
	_example:value	49
	_example:unitCode	P1
	example:foodApproval	true
	example:ColourOfBasicMaterial	
	_example:colourCodeValue	TRANSPARENT_NC
	_example:colourCodeListCode	ColourCodeList-CIRCULAR_PLASTICS
	example:applicationRange	PE1
	example:biodegradability	false
	example:AdditiveDetails	
	_example:additiveLevelOfContainment	LevelOfContainmentCode-CONTAINS
	_example:additiveCodeValue	MB_SL
	_example:density	
	__example:value	0.938
	__example:unitCode	23
	_example:surfaceWeight	
	__example:value	100
	__example:unitCode	25

The above example event already helps to answer some of the questions posed at the beginning of this section with regard to the packaging component:

3. Which additives does a given packaging component contain?
4. What is the colour of a packaging component's basic material?
5. Which material(s) and/or ingredients does a given packaging consist of?

In this production step of the first film there is the information for (5), the packaging ingredients (PE-LD), (4), the colour code (transparent) and (3), the additive code value (slip additive).

With the help of this information along the production process and the EPCIS events, these questions can be answered accordingly for the final packaging. Vice versa, the recycled content can also be calculated in this context, only for the packaging component. To better show the value of EPCIS and make it easier to understand the calculation of recycled content in this example, questions (1) and (2) are answered with regard to the final packaging:

To determine the percentage of recycled content, an appropriate formula is required. In this guideline, the agreed public formula of the Forum Rezyklat¹⁵ (FR) is applied. Currently, the calculation of FR is focused on PCR content, so we will adopt this in the following:

$$\text{Recycled content} = \frac{\text{mass of PCR included in the packaging material}}{\text{total mass of packaging material}} \times 100$$

For instance, assuming a given pouch has a weight of 15 g and a spout weighs 5 g, the total packaging weight is 20 g. Since the spout is not manually separable, it also has to be considered in the total.

The single production steps of the plastic pouch were documented with the different inputs in steps 1–10, so in the PackagingProducing event (11) the mass of the recycled content can be calculated with help of the data through the event chain (refer to figure 5-4). In this case, it should be 3 g recycled content for the pouch and 2 g recycled content for the spout. Putting this into the formula results as follows:

$$\text{Recycled content (\%)} = \frac{5g (\text{pouch with } 3g + \text{spout with } 2g)}{20g} \times 100 = 25\%$$

The recycled content of the packaging would therefore be 25 percent. Due to the availability of the single data points in the EPCIS events, the single masses need not be assumed but are given and the calculation is possible. The difference between using the Transformation Event and the Object Event can be seen again here. The Transformation Event uses the exact inputs. The subsequent calculation is more accurate in this case than with an Object Event.

5.5.2 Bottle

The production of a bottle is different to the production of a pouch, so other steps must be considered, but the event structure remains the same. In the following example, a plastic bottle containing three components, a body, a cap and a sleeve, is produced.

To better understand how the process and events fit together, the following graphic shows the steps with the produced components and the appropriate EPCIS events:

¹⁵ https://www.forum-rezyklat.de/fileadmin/user_upload/20221122__FR_Leitfaden_Rezyklat_V.2.0.pdf

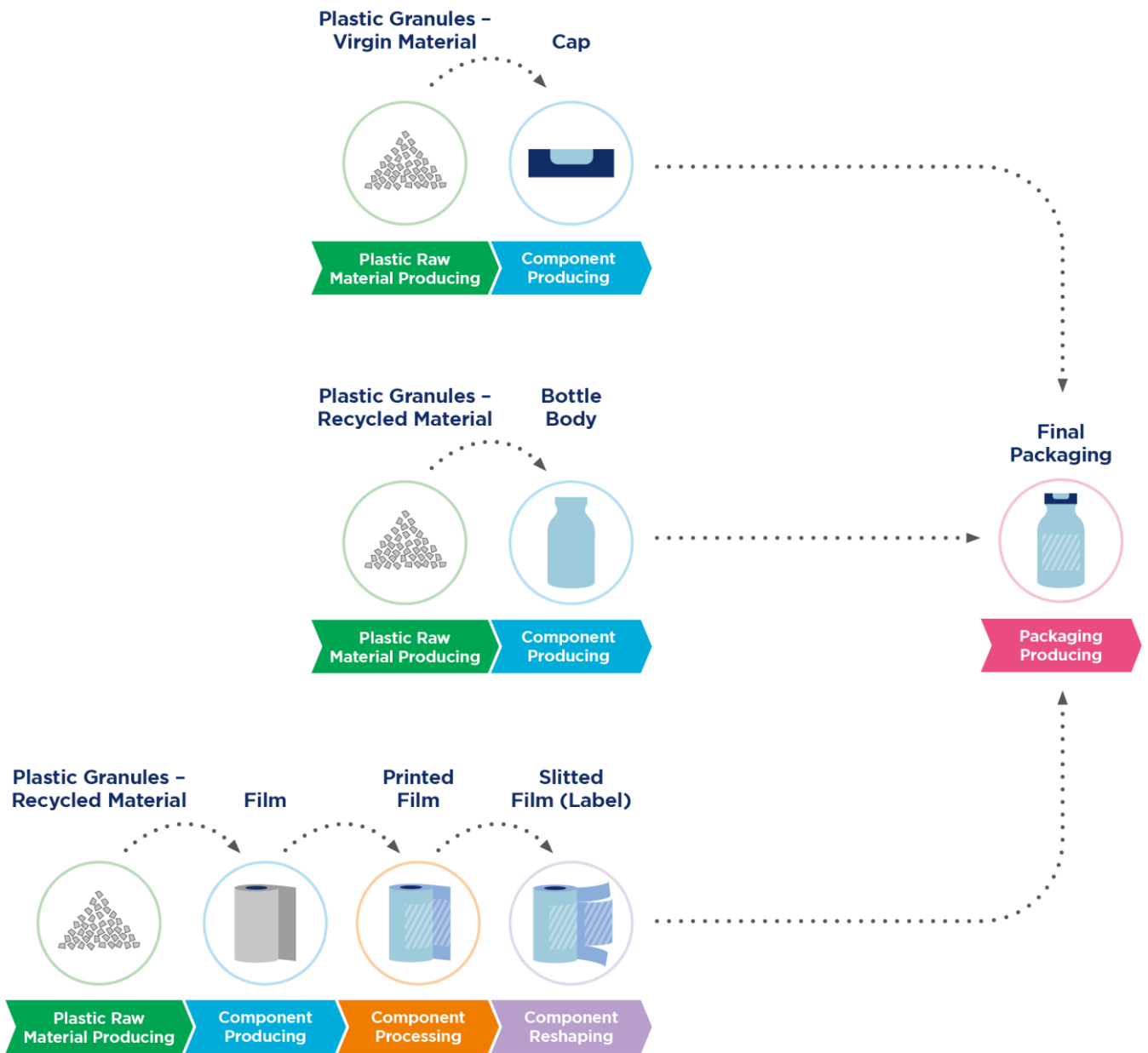


Figure 5-5.3: EPCIS events example: bottle

With the single process steps documented by EPCIS events, it is possible to trace single data points and to answer the questions mentioned in the beginning as with 1.1.1.

Again, a single production step should be looked at to gain a better understanding of the structure of EPCIS events. In this example, the visibility matrix shows the **PackagingProducing event** of the final packaging.

In this example, too, the input with the LGTIN is known, so a Transformation Event is chosen:

Dim	Data Element	Content
	Event Type	TransformationEvent
	eventID	ni:///sha-256;9fa42e8bf64e1cfe152d582a248646ce0ad2b0c6826c7e8ed95442a7a1545f33?ver=CBV2.0

The mentioned known input and the output are documented in the “What” dimension. The input for printing the film derives from the previous ComponentProducing event in which the production of the film roll was documented.

Dim	Data Element	Content
What	inputQuantityList	
	_epcClass	https://id.example.com/01/04012345111118/10/LOT123
	_quantity	66000
	_uom	H87
	outputQuantityList	
	_epcClass	https://id.example.com/01/04012345222227/10/LOT456
	_quantity	65850
	_uom	H87

To know when and where the event was captured, the next two segments are needed. The timestamp when the printed film was scanned is registered:

Dim	Data Element	Content
When	eventTime	2023-01-26T11:30:00.000Z
	eventTimeZoneOffset	+01:00
Where	readPoint	https://id.example.com/414/4012345000115/254/12

The appropriate “Why” dimension in this case must be “commissioning” for the related business step:

Dim	Data Element	Content
Why	bizStep	commissioning

To again obtain more information regarding the inks and additives, as well as other recycling-relevant data, the extensions must be considered.

Dim	Data Element	Content
Other (extension)	ilmd	
	_example:contentOfPackaging	COSMETICS
	_example:packageType	BO
	_example:ComponentDetails	
	_example:inputQuantity	https://id.example.com/01/04012345111118/10/LOT123
	_example:componentTypeCode	BODY
	_example:separabilityCode	NOT_REMOVABLE
	_example:unitWeight	
	example:value	73
	example:unitCode	GRM
	_example:inputQuantity	https://id.example.com/01/04012345111119/10/LOT444445
	_example:componentTypeCode	LABEL
	_example:separabilityCode	NOT_REMOVABLE
	_example:unitWeight	
	example:value	1
	example:unitCode	GRM
	_example:inputQuantity	https://id.example.com/01/04012345111120/10/LOT999999
	_example:componentTypeCode	CAP
	_example:separabilityCode	WIND_SIFTING
	_example:unitWeight	
	example:value	5
	example:unitCode	GRM

In this example, too, all input data is known and by tracking it through the EPCIS events it is possible to identify the recycled content of the final packaging. With the data from the EPCIS events, the actual value can be calculated.

For a better understanding of the calculation, the example will only use simple data: the bottle body has a weight of 73 g, the cap 5 g and the label 1 g. Since the bottle and the cap can be separated manually, they must be considered separately. The label cannot be separated. The share of the label related to the total weight is only 1.4 percent ($\frac{1g}{74g} = 0.0135$). Therefore, it can be calculated in the mass of material together with the bottle since it does not make up more than 5 percent of the total weight.

Assuming that 10 g PCR material was used to produce the bottle, the formula for recycled content of packaging already given in 1.1.1 can be applied as follows:

$$\text{Recycled content (\%)} = \frac{10g}{74g} \times 100 = 13.5\%$$

The share of recycled content in the cap is 0 percent since only virgin raw material was used.

With the help of the documentation of data through the EPCIS events, the recycled content of 13.5 percent for the shampoo bottle can be calculated.

Questions (3) to (5) from the beginning of the section can also be answered for this example as follows:

- the packaging contains Slip additives
- the colour of the bottle is light and
- the ingredients of this packaging material are PE-LD, PE-HD and ink.

It must be noted that this example data and elements only show a small range of possibilities within EPCIS. For more possible data elements, the sections of 5.4 should be considered.

6 Links and References

6.1 Links and References: Circular Packaging

- Legislation:

Circular Economy Action Plan (2020):

https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

Circular Economy Act (KrWG):

<https://www.gesetze-im-internet.de/krwg/>

Directive 94/62/EC on packaging and packaging waste (2018):

https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L0852&from=de#ntr1-L_2018150EN.01014101-E0001

Ecodesign for Sustainable Product Regulation 2022/0095 (COD) (2022):

https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en

European Parliament, Plastikmüll und Recycling in der EU: Zahlen und Fakten (2023):

<https://www.europarl.europa.eu/news/de/headlines/society/20181212STO21610/plastikmull-und-recycling-in-der-eu-zahlen-und-fakten>

European Strategy for Plastics in a Circular Economy (2018):

<https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX%3A52018DC0028>

Packaging Act (VerpackG) (2019):

<https://www.gesetze-im-internet.de/verpackg/>

- Others:

Building a Circular Economy for Packaging, Consumer Goods Forum (2020):

<https://www.theconsumergoodsforum.com/wp-content/uploads/Building-a-Circular-Economy-for-Packaging-July-15-2022.pdf>

Circular Data for a Circular Economy, GS1 in Europe (2020):

<https://www.gs1.eu/publications>

Impact of international, open standards on circularity in Europe – Leveraging the power of data to support circular supply chains, Deloitte (2022):

<https://www2.deloitte.com/pl/pl/pages/zarzadzania-procesami-i-strategiczne/articles/Impact-of-GS1-standards-on-circularity-in-Europe.html>

Digital Product Passport Architecture, GS1 in Europe (2022):

<https://www.gs1.eu/news/eu-digital-product-passport-revealed-time-to-act>

Forum Rezyklat, Leitfaden Rezyklat (2022):

https://www.forum-rezyklat.de/fileadmin/user_upload/20221122_FR_Leitfaden_Rezyklat_V.2.0.pdf

Ocean plastic pollution an overview: data and statistics, Intergovernmental Oceanographic Commission (2022):

<https://oceanliteracy.unesco.org/plastic-pollution-ocean/>

Packaging Design for Recycling (2020):

<https://ecr-austria.at/arbeitsgruppen/publikationen/>

Plastics Packaging in a Closed Loop, acatech/Circular Economy Initiative Deutschland/SYSTEMIQ (2021):

<https://www.circular-economy-initiative.de/de-publikationen>

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (2022):

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0677>

The Global Commitment 2021 Progress Report, EllenMacArthur Foundation (2022):

<https://ellenmacarthurfoundation.org/global-commitment/overview>

6.2 Links and References: GS1 Standards

Core Business Vocabulary Standard version:

<https://ref.gs1.org/standards/cbv/>

EPCIS and CBV Implementation Guideline:

<https://ref.gs1.org/guidelines/epcis-cbv/>

EPCIS/CBV Standard:

<https://www.gs1.org/standards/epcis>

Global Standards Management Process (GSMP) Manual:

<https://www.gs1.org/standards/gsm-manual/current-standard#1-Introduction>

GS1 Digital Link:

<https://www.gs1.org/standards/gs1-digital-link>

GS1 General Specifications:

<https://www.gs1.org/standards/barcodes-epcrid-id-keys/gs1-general-specifications>

GS1 Global Location Number rules:

<https://www.gs1.org/1/glnrules/en/>

GS1 Global Product Classification:

<https://www.gs1.org/standards/gpc>

GS1 Global Traceability Standard:

https://www.gs1.org/sites/default/files/docs/traceability/GS1_Global_Traceability_Standard_i2.pdf

GS1 Web Vocabulary:

<https://www.gs1.org/gs1-web-vocabulary>

7 Annex

A.1 Code values of recycling-relevant field names in EPCIS events

General remarks

- Code Values for the field names “adhesives” and “inks” are not available at the time of writing this Guideline. The Guideline will be updated as soon as they have been defined.
- The maturity level of standardisation of the mentioned attributes and code values below is highlighted with different colours. These are the identified levels of standardisation:
 1. Standardised in GS1 WebVoc (URI available) and available in the correct domain: transparent / white background colour
 2. Standardised through GS1, but not in GS1 WebVoc in the correct domain or just in the GDSN/GDD, must pass through GSMP: marked with background colour orange
 3. Not standardised, proposal initiated by this group, must pass through GSMP: marked with background colour grey

1. Additives

Additives		
Code value ¹⁶	Code name	Code definition
MB_AF	Anti-fog	Anti-fog additives are often used in food packaging and greenhouse films to prevent the plastic product from becoming cloudy (fogging) due to small water droplets.
MB_AS	Anti-static	Anti-static agents can be used in all kind of plastic processing processes like film extrusion, injection moulding, blow moulding, fibre spinning, etc. They are used to eliminate the accumulation of electrical charge on their surfaces in a wide variety of applications such as packaging, electrical components, automotive.
MB_UV	UV-stabilizer	UV masterbatches protect the polymers from degradation by UV radiation and prevent discolouration. They do not absorb the harmful UV rays, but ensure the performance of the product and stabilise the mechanical properties. High additive concentrations are used for outdoor applications.
MB_SL	Slip additive	Slip additives are added to polymers to reduce friction. They migrate to the surface of the polymer product when it cools after processing so that a slip layer forms. They can be used in polymer films and plastic packaging to improve the processing and handling properties of polymers and are a practical requirement for the manufacturer and the end user.

¹⁶ MB stands for master batch. The term master batch (MB) means plastic additives in the form of granules with additive contents that are higher than in the final application. They are added to the plastic (raw material) to change the properties.

Additives		
MB_XP	Expansion/cavitating additives	Expansion and cavitating additives are mainly used for production of films and oriented films (BO- or MDO-process). They lead to white-opaque – sometimes pearlescent – packaging and to reduction of the film density because of the creation of cavities in the film. Examples are PBT masterbatches for BOPP films and VO+ masterbatch for MDO-PE films.
MB_AC	Acetaldehyde blockers	Acetaldehyde is generated in small quantities at the high processing temperatures of PET and can lead to sweetish off-flavours in water. For this reason, an acetaldehyde blocker is added to the PET polymer/recyclate to block or chemically bind acetaldehyde, especially in the production of PET bottles for mineral water.
MB_OB	Optical brightener	Optical brighteners, also known as fluorescent brighteners, are additives that change the optical properties of polymers. Optical brighteners are generally applied to improve the colour of various plastics. They are also used to reduce the typical yellow undertones of recycled materials.
MB_OS	Oxygen scavenging	Oxygen scavengers or oxygen absorbers are added to closed packages to reduce or remove the oxygen content in the package. They are used to ensure product safety and extend shelf life.
MB_CB	Carbon black	Carbon black masterbatches are used to colour plastics black. However, they are not only used to provide colour to plastics, but also to give them special properties such as conductivity and light stability. This substance is problematic because it prevents the detection of polymer types by NIR sensors in sorting lines for recycling.
MB_PA	Polyamide additive	Polyamide additives are e.g. used for PET bottles to improve the barrier properties for applications where higher barriers are required.
MB_IV_ENH	IV Enhancer	The typical IV loss (IV: intrinsic viscosity) during the recycling of PET can be counteracted by appropriate processing technology or by adding IV enhancer, also called chain extender, for recycled PET. This means that the IV value can be adjusted to the values required for processing by adding this additive.
other	Other recycling-relevant additive	There are additives but it is not known in detail whether they are recycling-relevant.

3. Application range

Application range		
Code Values	Code Name	Code Definition
PE1	Film extrusion, blow moulding of bottles and drums for PE1	0.2-5.0 g/10min @2.16 kg, 190 °C for PE
PE2	Injection moulding, blow moulding of drums and jerry cans for PE2	4.0-10.0 g/10min @2.16 kg, 190 °C for PE
PP1	Film extrusion (BOPP, CPP, blown PP) for PP1	0.8-12.0 g/10min @2.16 kg, 230 °C for PP
PP2	Injection moulding, blow moulding of caps, closures, bottles, for PP2	1.0-30 g/10min @2.16 kg, 230 °C for PP

Application range		
PP3	Injection moulding of thick-walled products like drinking cups, for PP3	30-60 g/10min @2.16 kg, 230 °C for PP
PP4	Injection moulding of thin-walled products like buckets and boxes, for PP4	60-100 g/10min @2.16 kg, 230 °C for PP
PET1	Film extrusion for trays, lidding or lamination film like BOPET, for PET1	0.58-0.74 dl/g (IV) for PET
PET2	Film extrusion for G-PET sleeves, etc., for PET2	0.70-0.80 dl/g (IV) for PET
PET3	Injection moulding, blow moulding, etc. for bottles, for PET3	0.75-0.85 dl/g (IV) for PET
PA1	Film extrusion, for PA1	2.6-4.2 @1% [m/v] in 96% H2SO4 (RV) for PA

5. Coatings

Coatings		
Code Values	Code Name	Code Definition
ALU_COATING	Aluminium Coating	Typical 3-500 nm metallizing layer; can be detected by a metal detector.
ALOX_SIOX	ALOX/ SIOX	Coating which typically is 5-20 nm layer thick and which is transparent.
OTHER	Other coating	coating not specified in any other code

6. Colour of basic material / 7. Colour of printing: ColourCodeList-CIRCULAR_PLASTICS¹⁷

Colour of basic material / Colour of printing		
Code Values	Code Name	Code Definition
TRANSPARENT_NC	Transparent – non coloured	transparent / clear – non coloured, that is easy to see through
TRANSPARENT_BL	Transparent – blue	mainly needed for PET bottles, but can be also valuable for other packaging types, that are easy to see through
TRANSPARENT_LB	Transparent light-blue	mainly needed for PET bottles, but can be also valuable for other packaging types, that are easy to see through
TRANSPARENT_GR	Transparent – green	mainly needed for PET bottles, but can be also valuable for other packaging types that are easy to see through
TRANSPARENT_BR	Transparent – brown	mainly needed for PET bottles, but can be also valuable for other packaging types, that are easy to see through

¹⁷ Remark: The data fields "Colour of basic material" and "Colour of printing" rely on the same codelist named ColourCodeList-CIRCULAR_PLASTICS. In the course of placing the recycling-relevant GSMP work requests on global level this list and their code values and descriptions will be added. The outcome will depend on decisions taken by the accountable GSMP group.

Colour of basic material / Colour of printing		
WHITE	White	white
LIGHT	Light colour	light colour
DARK	Dark colour	dark colour
BLACK	Black	black

8. Component type

Component type		
Code Values	Code Name	Code Definition
BOTTLE	Bottle	A container having a round neck of relatively smaller diameter than the body, as compared with a jar, and an opening capable of holding a closure for retention of the contents. The cross section of the bottle may be round, oval, square, oblong, or a combination of these. Bottles generally are made of glass or plastic but can also be earthenware or metal. Bottle may be disposable, recyclable, returnable, or reusable.
CAP	Cap	A cap that seals a bottle or other form of packaging.
TRAY	Tray	A shallow container, which may or may not have a cover, used for displaying, carrying items or carry for warehousing. Examples for TIIG <ul style="list-style-type: none"> • Plate • Cardboard carrier • Cellplate • Divider Sheet/Slip Sheet • Plastic-Wrapped Tray • Tray for bottles • Tray one layer no cover • Tray tablet • Tray Shrinkpacked • Tray/Tray pack • Other Information • This code also covers all 'ready to cook' plates in which some products are sold. • Divider Sheets/Slip Sheets which are used to hold layers on a pallet for efficient cross docking warehousing processes.
LABEL	Label	A label is a piece of paper, polymer, cloth, metal, or other material affixed to a container or article (or printed directly upon it), which usually carries information about the article to which it has been attached.
BODY	Body	The main body of a package, often used for flexible packaging.
LID	Lidding	In packaging, the top or bottom of a container, usually the part that closes the opening; may also be known as cap, over, or top.
SLEEVE	Sleeve	A tubular form, open at both ends, that is slipped over an item or package.
CLOSURE	Closure	The closure of a package, if it cannot be described as a cap, for example a zipper or a retaining clip.
SPOUT	Spout	A spout is a protruding edge which allows the lifting and pouring of liquids contained within a container.
PAD	Pad	A pad can be used to separate packaged goods, for example between slices of cheese or like a sheet between bottles during shipping. Or it can be an absorbent pad which soak up the liquids that naturally ooze out of meat, poultry, and seafood over time, preventing them from pooling in the package.
SPRAY_HEAD	Spray head	A spray head is the outlet attached to a bottle or can through which liquids are ejected, usually by manual pressing.
HANDLE	Handle	A grip attached to an object for using or moving the object, usually with the hands.

SEC_PACK	Secondary packaging	Secondary packaging is the second layer of packaging applied to a product after the primary packaging layer. Common types of secondary packaging are cartons, trays, and collation shrink film.
LINER	Liner	An internal chamber within a container which separates the content of the container from the walls. Inner liners provide additional isolation and protection to the content of a container. Sometimes coatings of certain materials may be applied as an alternative to inner liners.
OTHERS	Others	Component is known but not listed.

9. Content of packaging

Content of packaging		
Code Values	Code Name	Code Definition
FOOD	food	All kinds of food (and pet foods).
MEDICINE	medicine	Medicine, solids or liquids.
COSMETICS	cosmetics	Cosmetics, solid, liquid or creamy.
DETERGENT	detergent	Detergents, solids or liquids.
OTHER_HAZARDOUS	none of the categories, hazardous	Hazardous product according to CLP regulation.
OTHER_NON-HAZARDOUS	none of the categories, non-hazardous	Content that does not belong to any other category.

11. Fillers

Fillers		
Code Values	Code Name	Code Definition
CACO3	Calcium Carbonate	Ground calcium carbonate and precipitated calcium carbonate products serve as functional fillers in plastic and rubber applications. Calcium carbonate is widely used as in polyvinyl chloride (PVC), polyolefin, polypropylene (PP), polyethylene (PE) and unsaturated polyester resins applications.
TIO2	Titanium dioxide	TIO2 is mostly used in the form of masterbatch (additional input material to polymers used for colouring and/or for properties' change) to colour the polymer (film or 3D body) white.
MINERAL_OTHER	Mineral other	Any other mineral-based material not available in this list. Should be used as a temporary measure while a proper code is established.

14. Input material origin (GDSN codelist: PackagingRawMaterialCode)¹⁸

Input material origin		
Code Values	Code Name	Code Definition
PIR_C	PIR chemical	Recyclate that originates from post-industrial waste (according to DIN EN ISO 14021:2016) and is chemically recycled.

¹⁸ In the course of placing the recycling-relevant GSMP work requests on global level the missing code values listed in this attribut, their code name and description will be added to the existing GDSN code list „PackagingRawMaterialCode“. The outcome will depend on decisions taken by the accountable GSMP group.

Input material origin		
PIR_M	PIR mechanical	Recyclate that originates from post-industrial waste (according to DIN EN ISO 14021:2016) and is mechanically recycled.
PCR_C	PCR chemical	Recyclate that originates from post-consumer waste (according to DIN EN ISO 14021:2016) and is chemically recycled.
PCR_M	PCR mechanical	Recyclate that originates from post-consumer waste (according to DIN EN ISO 14021:2016) and is mechanically recycled.
BIO_BASED	bio-based	Virgin material based on renewable resources.
FOSSILE_BASED	fossile-based	Virgin material based on fossile resources.

16. Package type

Package type		
Code Values	Code Name	Code Definition
AA	Intermediate bulk container, rigid plastic (RIBC)	A Rigid Intermediate Bulk Container (RIBC) that is attached to a pallet or has the pallet integrated into the RIBC. The container is used for the transport and storage of fluids and other bulk materials.
AE	Aerosol	A gas-tight, pressure-resistant container with a valve and propellant. When the valve is opened, propellant forces the product from the container in a fine or coarse spray pattern or stream. (e.g., a spray can dispensing paint, furniture polish, etc, under pressure). It does not include atomizers, because atomizers do not rely on a pressurised container to propel product from the container.
AM	Ampoule	A relatively small container made from glass or plastic tubing, the end of which is drawn into a stem and closed by fusion after filling. The bottom may be flat, convex, or drawn out. An ampule is opened by breaking the stem.
BA	Barrel	A cylindrical packaging whose bottom end is permanently fixed to the body and top end (head) is either removable or non-removable.
BBG	Bag in Box	Bag-In-Box or BIB is a type of container for the storage and transportation of liquids. It consists of a strong bladder, usually made of aluminium PET film or other plastic seated inside a corrugated fibreboard box. The box and internal bag can be fused together. In most cases there is nozzle or valve fixed to the bag. The nozzle can be connected easily to a dispensing installation or the valve allows for convenient dispensing.
BG	Bag	A preformed, flexible container, generally enclosed on all but one side, which forms an opening that may or may not be sealed after filling.
BJ	Bucket	A container, usually cylindrical, can be equipped with a lid and a handle. (e.g., a pail made of metal, plastic, or other appropriate material).
BK	Basket	A semi rigid container usually open at the top traditionally used for gathering, shipping and marketing agricultural products.
BO	Bottle	A container having a round neck of relatively smaller diameter than the body, as compared with a jar, and an opening capable of holding a closure for retention of the contents. The cross section of the bottle may be round, oval, square, oblong, or a combination of these. Bottles generally are made of glass or plastic but can also be earthenware or metal. Bottle may be disposable, recyclable, returnable, or reusable.

Package type		
BPG	Blister pack	A type of packaging in which the item is secured between a preformed (usually transparent plastic) dome or "bubble" and a paperboard surface or "carrier." Attachment may be by stapling, heat-sealing, gluing, or other means. In other instances, the blister folds over the product in clam-shell fashion to form an enclosing container. Blisters are most usually thermoformed from polyvinyl chloride; however, almost any thermoplastic can be thermoformed into a blister.
BRI	Brick	A rectangular-shaped, stackable package designed primarily for liquids such as juice or milk.
BX	Box	A non-specific term used to refer to a rigid, three-dimensional container with closed faces that completely enclose its contents and may be made out of any material. Even though some boxes might be reused or become resealed they could also be disposable depending on the product hierarchy.
CG	Cage	A container enclosed on at least one side by a grating of wires or bars that lets in air and light.
CM	Card	A flat package to which the product is hung or attached for display.
CMS	Clam Shell	A one-piece container consisting of two halves joined by a hinge area which allows the structure to come together to close. Clamshells get their name from their appearance to the shell of a clam, which it resembles both in form and function.
CNG	Can/Tin	A metallic and generally cylindrical container of unspecified size which can be used for items of consumer and institutional sizes.
CR	Crate	A non-specific term usually referring to a rigid three-dimensional container with semi-closed faces that enclose its contents for shipment or storage. Crates could have an open or closed top and may have internal dividers. Even though some crates might be reused or become resealed they could also be disposable depending on the product hierarchy.
CQ	Cartridge	A container holding a item or substance, designed for insertion into a mechanism. Examples: Ink. Beverage Syrup.
CS	Case	A non-specific term for a container designed to hold, house, and sheath or encase its content while protecting it during distribution, storage and/or exhibition. Cases are mostly intended to store and preserve its contents during the product's entire lifetime.
CT	Carton	A non-specific term for an open or re-closable container used mostly for perishable foods (e.g. eggs, or fruit).
CU	Cup/Tub/Bowl	A flat-bottomed container that has a base of any shape and which may or not be closed with a lid. Usually made of paper, plastic or other materials these containers are typically used to contain mostly (but not exclusively) foods such as ice cream, margarine, yogurt, sour cream, confections, etc.
CY	Cylinder	A rigid cylindrical container with straight sides and circular ends of equal size.
EN	Envelope	A predominantly flat container of flexible material having only two faces, and joined at three edges to form an enclosure. The non-joined edge provides a filling opening, which may later be closed by a gummed or adhesive flap, heat seal, tie string, metal clasp, or other methods.
GTG	Gable Top	A rectangular-shaped, non-stackable package designed primarily for liquids such as juice or milk.
JG	Jug	A container, normally cylindrical, with a handle and/or a lid or spout for holding and pouring liquids.
JR	Jar	A rigid container made of glass, stone, earthenware, plastic or other appropriate material with a large opening, which is used to store products, (e.g., jams, cosmetics).

Package type		
MPG	Multipack	A bundle of products held together for ease of carriage by the consumer. A multipack is always a consumer unit.
NE	Not packed	The item is provided without packaging.
NT	Net	A container of meshwork material made from threads or strips twisted or woven to form a regular pattern with spaces between the threads that is used for holding, carrying, trapping, or confining something.
PB	Pallet Box	A three-dimensional container which either has a pallet platform permanently attached at its base or alternatively requires a platform for its handling and storage as due to its constitution it cannot be handled without it. The characteristics of the platform should be specified using the pallet type code list.
PLP	Peel Pack	A package used for sterile products which may be torn open without touching the product inside.
PO	Pouch	A preformed, flexible container, generally enclosed with a gusset seal at the bottom of the pack can be shaped/arranged to allow the pack to stand on shelf.
PT	Pot	A flat-bottomed container that has a base of any shape and which may or not be closed with a lid. Pots are usually made of cardboard, plastic, ceramic, metal or other materials and may be used for a wide array of products such as cosmetics, food/liquids, dairy products, plants.
PU	Tray	A shallow container, which may or may not have a cover, used for displaying, carrying items or carry for warehousing. Examples for TIIG <ul style="list-style-type: none"> • Plate • Cardboard carrier • Cellplate • Divider Sheet/Slip Sheet • Plastic-Wrapped Tray • Tray for bottles • Tray one layer no cover • Tray tablet • Tray Shrinkpacked • Tray/Tray pack • Other Information • This code also covers all 'ready to cook' plates in which some products are sold. • Divider Sheets/Slip Sheets which are used to hold layers on a pallet for efficient cross docking warehousing processes.
PUG	Packed, unspecified	Packaging of the product (or products) is currently not on the list. Use this code when no suitable options are available and only while a Change Request is approved for the proper packaging type.
PX	Pallet	A platform used to hold or transport unit loads.
RK	Rack	A non specific term identifying a framework or stand for carrying, holding, or storing items. Commonly on wheels and primarily used in the logistical functions to deliver items such as hanging garments, or items on shelves such as dairy products and bakery items and flowers.
RL	Reel	A spool on which thread, wire, film, etc, is wound. Any device on which a material may be wound. Usually has flanged ends and is used for shipping or processing purposes.
RO	Roll	Roll
STR	Stretchwrapped	In packaging, a high-tensile plastic film, stretched and wrapped repeatedly around an item or group of items to secure and maintain unit integrity. The use of stretch film to tightly wrap a package or a unit load in order to bind, protect and immobilize it for further handling or shipping.

Package type		
SW	Shrinkwrapped	In packaging, a plastic film around an item or group of items which is heated causing the film to shrink, securing the unit integrity. The use of shrunken film to tightly wrap a package or a unit load in order to bind, protect and immobilize it for further handling or shipping.
SY	Sleeve	A non-rigid container usually made of paper, cardboard or plastic, that is open-ended and is slid over the contents for protection or presentation.
TU	Tube	A cylindrical container sealed on one end that could be closed with a cap or dispenser on the other end.
WIRE	Wire (non-specific material in the form of very flexible thread or slender rod)	A packaging made of a non-specific material in the form of very flexible thread or slender rod.
WRP	Wrapper	The process of enclosing all or part of an item with layers of flexible wrapping material (e.g., for an individually packed ice cream). Does not include items which are shrink-wrapped or vacuum-packed.
X11	Banded package	Something used to bind, tie, or encircle the item or its packaging to secure and maintain unit integrity.
ZU	Flexible Intermediate Bulk Container	A non-rigid container used for transport and storage of fluids and other bulk materials. The construction of the IBC container and the materials used are chosen depending on the application.

17. Packaging ingredient details

Packaging ingredient details		
Code Values	Code Name	Code Definition
	Polymer Types	see Attribute „PolymerTypes“
	Fillers	see Attribute „Fillers“
	Inks	list not available yet, see 7
	Coating	see Attribute „Coating“
	Adhesives	list not available yet, see 7
PAPER_PAPER	Paper	A non-specific sheet material produced by the matting of fibres from wood, rags, or other fibrous materials. Generally, paper is of a lesser thickness or weight than paperboard.
METAL_ALUMINUIM	Aluminium	A non specific material made from aluminum or aluminum alloy.

18. Polymer types¹⁹

Polymer types		
Code Values	Code Name	Code Definition

¹⁹ Terms for Code Values of polymers are taken from DIN EN ISO 1043-1 Plastics – Symbols and abbreviated terms – Part 1: Basic polymers and their special characteristics.

Polymer types		
PE-LD	Low-Density Polyethylene (LDPE)	This group includes all low-density polyethylene types which means typically in packaging applications a density of 0.918-0.940 g/cm ³ . It also includes LDPE-based tie resins and LDPE-based masterbatches.
PE-LLD	Linear Low-Density Polyethylene (LLDPE)	This group includes all linear low-density polyethylene types, for example LLDPE, mLLDPE, VLLDPE, plastomers, LLDPE-based tie resins and LLDPE-based masterbatches.
PE-HD	High-Density Polyethylene (HDPE)	This group includes all high-density polyethylene types which means typically in packaging applications a density of 0.941-0.969 g/cm ³ .
PE	Polyethylene (PE)	All types and mixtures of polyethylene polymers. As a more precise specification of the PE types (see above) is often preferable, this code should only be used if there is a mixture of PE types, for example after recycling, or if the used PE types are not known more precisely.
PP	Polypropylene (PP)	This code includes HomoPP, mPP, PP-based tie resins and PP-based masterbatches. It is also used if there is a mixture of PP types, for example after recycling, or if the used PP types are not known more precisely.
PP-R	Polypropylen Random-Copolymer (PP-R)	This code includes random copolymers of polypropylene, CoPP-based tie resins, mPP and PP terpolymers.
PP-B	Polypropylen Block-Copolymer (PP-B)	This code contains polypropylen block-copolymers, like heterophasic copolymers of polypropylene (HeCoPP).
EVAC_EBAK	Ethylene-Vinylacetate-Copolymers (EVAC) and Ethylene-Butylacrylate Copolymers (EBAK)	This group contains the ethylene-vinylacetate-copolymers and ethylene-butylacrylate copolymers. It also includes ethylen-vinylacetat-based and ethylene-butylacrylate tie resins and masterbatches.
PA	Polyamid (PA)	This includes all polyamide types, for example PA6, CoPA, PA12 and PA-based masterbatches.
EVOH	Ethylene Vinyl Alcohol (EVOH)	All types of ethylene vinyl alcohol polymers, commonly used in food applications to provide barrier to oxygen and other gases.
PET	Polyethylenterephthalat, amorph (PET-A) or crystalline (PET-C)	This group contains amorph polyethylenterephthalates (A-PET), crystalline polyethylenterephthalates (C-PET) and PET-based masterbatches.
PET-G	Polyethylenterephthalat, glycol-modified (PET-G)	This code includes glycol-modified polyethylenterephthalates (G-PET) and other polyethylenterephthalat copolyesters.
PS	Polystyrene (PS)	This includes all polystyrene types, e.g. standard/general purpose polystyrene (PS, sometimes GPPS), high impact polystyrene (HIPS), but not expandable and expanded polystyrene (EPS).
PS-E	Expandable and Expanded Polystyrene (EPS)	This code includes expandable and expanded polystyrene (EPS). Expanded polystyrene is mainly known under the trade name Styropor®.

Polymer types		
PLA_PHA	Polylactic Acids (PLA) and Polyhydroxyalkanoates (PHA)	This group contains polylactic acids (PLA) and polyhydroxyalkanoates (PHA); these polymers are bio-based and bio-degradeable. The code also includes PLA-based and PHA-based tie resins and masterbatches.
PVC	Polyvinyl Chloride (PVC)	This group contains all types of vinyl chlorides which are used in packaging applications.
PO	Mixtures of PE and PP resins (polyolefins)	This code includes all types of PE and PP types as well as polyolefins like polyisobutylene (PIB) and polybutylene (PB). It should only be used if there is a mixture of PE and PP types, for example after recycling, because if possible a more precise specification is preferable.
MIX	Mixtures of thermoplastic polymers	This code represents mixtures thermoplastic polymers. It should only be used if there is a mixture of different thermoplastic polymers, for example after recycling, because if possible a more precise specification is preferable.
PIB	Polyisobutylene (PIB)	Code for polyisobutylene (PIB).
PVAL	Polyvinyl Alcohol (PVAL)	Code for polyvinyl alcohol (PVAL), sometimes also abbreviated as PVOH or PVA. Polyvinyl alcohol is a biodegradable and highly water soluble polymer with high gas and grease barrier.
PVDC	Polyvinylidene Di-Chloride (PVDC)	Code for polyvinylidene di-chloride (PVDC) and compounds with PVDC. It is used in films or, for example, as a sealing gasket material and often used for coating of films (typically 1-3 µm layer thickness).
PUR	Polyurethan (PUR)	Code for polyurethan (PUR). It is used in films or, for injection moulding as well as for coating applications (here typically 0.1 µm layer thickness).
TPE	Thermoplastic Elastomer (TPE)	This group contains all types of thermoplastic elastomers (TPE), e.g. also thermoplastic polyurethane (TPU), styrene block copolymers (TPS).
OTHER	Other polymer	A material not specified in any other code, but which is a thermoplastic or thermosetting polymer.

19. Print type

Print type			
Attribute Name	Code Values	Code Name	Code Definition
printType	SURFACE_PRINT	Surface Print	Printing on the surface, if necessary with a protective varnish.
printType	INTERLAYER_PRINT	Interlayer Print	The print layer is sandwiched between two substrate layers; this is usually achieved by first printing a substrate and then gluing a second substrate onto this print layer.

20. Separability code

Separability code		
Code Values	Code Name	Code Definition
NOT_REMOVABLE	not removable	Not removable
WIND_SIFTING	wind sifting after cutting	Removable in wind sifting
COLD_WASHING	cold washing after cutting	Removable in cold-washing process
HOT_WASHING65	hot washing 65 after cutting	Removable in hot-washing process at 65 °C
HOT_WASHING80	hot washing 80 after cutting	Removable in hot-washing process at 80 °C
BY_CONSUMER	removable by consumer	Consumer can remove the component
IRREVERSIBLE_DURING_CONSUMPTION	Irreversible removable during use or consumption	Consumer must remove/separate the component irreversibly during use or consumption
SINK_FLOAT	density separation by sink float method after cutting	Removable by sink-float method

23. Waste class

Waste Class		
Code Values	Code Name	Code Definition
	Polymer Types	see Attribute „polymerTypes“
PAPER_PAPER	Paper	A non-specific sheet material produced by the matting of fibres from wood, rags, or other fibrous materials. Generally, paper is of a lesser thickness or weight than paperboard.
METAL_ALUMINIUM	Aluminium	A non specific material made from aluminum or aluminum alloy.

24. Waste origin

Waste origin		
Code Values	Code Name	Code Definition
PCR_MIX_COL	PCR from mixed collection	Post-consumer recycling material according to DIN EN ISO 14021:2016, from municipal or household collection system (e.g. yellow bin) and residual collections.
PCR_SEL_COL	PCR from selective collection	Post-consumer recycling material according to DIN EN ISO 14021:2016, from selective collection, e.g. collected from the back store in a super market.
PIR_INHOUSE	PIR which is inhouse recycled	Post-industrial recycling material according to DIN EN ISO 14021:2016, which is recycled directly at the site where it is generated.
PIR_INDUSTRIAL	PIR which is recycled in another facility	Post-industrial recycling material according to DIN EN ISO 14021:2016, which is sold/transported for recycling to another facility/company.

Imprint

Editor:
GS1 Germany GmbH

CEO:
Thomas Fell

Text:
GS1 Germany GmbH

GS1 Germany GmbH
Maarweg 133, D-50825 Cologne

Postfach 30 02 51
D-50772 Cologne

Tel: +49 (0)221 94714-0
Fax: +49 (0)221 94714-990

Email: info@gs1.de
Homepage: www.gs1.de

© GS1 Germany GmbH, Cologne

GS1 Germany GmbH

Maarweg 133

50825 Köln

T +49 221 94714-0

F +49 221 94714-990

E info@gs1.de

www.gs1.de

