PRODUCT ENVIRONMENTAL PROFILE

Environmental Product Declaration

TF65/TF96 Thermal Overload Relay

April 2024

TF96

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EPD Owner	ABB STOTZ-KONTAKT GmbH, Eppelheimer Strasse 82 69123 Heidelberg, Germany www.abb.com
Manufacturer name and address	ABB Xinhui Low Voltage Switchgear Co., Ltd. Xinhui district, Jiangmen city, Guangdong Province, 529100, P.R. China.
Company contacts	EPD_ELSP@in.abb.com
Reference product	TF96-96 Thermal Overload Relay
Description of the product	TF range of Thermal Overload Relay ensures high protection and reliable operation in critical power applications, distribution boards, switchboards, capacitor banks. A wide range of cable terminals and Snap-On accessories make the installation easy and fast. TF Range can be fitted into different distribution systems by means of busbar adapters
Functional unit	The functional unit to this study is a Thermal Overload Relay (including its packaging and accessories), Switch on and off during 20 years electrical power supply of a downstream installation with an electrical and/or mechanical control. The functional unit is characterized by control circuit voltage Uc =24V, 60V, 125V, 250V, a power circuit voltage Up and a maximum allowed intensity by the power circuit Ip
Other products covered	TF65-28 TF65-60 TF96-78 TF65-47B TF96-60B TF65-33 TF65-67 TF96-87 TF65-53B TF96-68B TF65-40 TF96-51 TF65-28B TF65-60B TF96-78B TF65-47 TF96-60 TF65-33B TF65-67B TF96-87B TF65-53 TF96-68 TF65-40B TF96-51B TF96-96B
Reference lifetime	20 years
Product category	Electrical, Electronic and HVAC-R Products
Use Scenario	The use phase has been modeled based on the sales mix data (2022), and the corresponding low voltage electricity countries mix
Geographical representativeness	Raw materials & Manufacturing: [Global] Assembly: [China] Distribution / Use: [Global] specific sales mix EoL: [Global]
Technological representativeness	Materials and processes data are specific to the production of TF96-96 Thermal Overload Relay
LCA Study	This study is based on the LCA study described in the LCA report 1SAC200246H0001
EPD type	Product Family Declaration
EPD scope	“Cradle to grave”
Year of reported primary data	2022
LCA software	SimaPro 9.5.0.1 (2023)
LCI database	Ecoinvent v3.9.1 (2023)
LCIA methodology	EN 15804:2012+A2:2019

Contents

ABB Purpose & Embedding Sustainability

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 105 thousand talented employees in over 100 countries.

ABB's Electrification business offers a wide-ranging portfolio of products, digital solutions and services, from substation to socket, enabling safe, smart and sustainable electrification. Offerings encompass digital and connected innovations for low voltage and medium voltage, including EV infrastructure, solar inverters, modular substations, distribution automation, power protection, wiring accessories, switchgear, enclosures, cabling, sensing and control.

ABB is committed to continually promoting and embedding sustainability across its operations and value chain, aspiring to become a role model for others to follow. With its ABB Purpose, ABB is focusing on reducing harmful emissions, preserving natural resources and championing ethical and humane behavior.

General Information

ABB Xinhui Low Voltage Switchgear Co., Ltd, located in Xinhui District, Jiangmen City, Guangdong Province, the hometown of overseas Chinese. It is a joint venture company of ABB specializing in the production of low-voltage electrical appliances in China. The company mainly produces low voltage molded case circuit breakers (Tmax XT, Tmax and Formula) for power distribution protection and control, ATS automatic transfer switch appliances, Compact/Modular series pilot devices, OT isolating switches, OS isolating switch fuses, PSR/PSTX series softstarters, electronic overload relays E/EF, thermal overload relays TF, Manual Motor Starters MS, A/AS/AF/AX series contactors, etc. In addition to meeting the needs of domestic customers, the products are also exported to markets such as Europe and Asia.

Thermal Overload Relay product cluster

The TF65/TF96 Thermal Overload Relay is an economic electromechanical protection device for the main circuit. It offers reliable and fast protection for motors in the event of overload or phase failure. Further features are the temperature compensation, trip contact (NC), signal contact (NO), automatic- or manual reset selectable, trip-free mechanism, STOP function and a trip indication. The overload relays are connected directly to the block contactors.

TF65/TF96 is a compact and powerful range for Thermal Overload Relays. They offer a reliable protection for Thermal Overload Relay in the event of overload or phase failure. This type has also a clear and reliable indication of fault in a separate window in the event of short-circuit tripping. Further features are the build-in disconnect function, temperature compensation, trip-free mechanism, and a rotary handle with a clear switch position indication. The Thermal Overload Relay is suitable for three- and single-phase applications.

- **TF96-96**

Thermal Overload Relay	TF96-96
Rated voltage [V]	690
Rated current [A]	96
Utilization Category	AC-3
Number of Poles	3

Table 1: Technical characteristics of TF96-96 Thermal Overload Relay
(Refer Technical catalogue for complete details).

Constituent Materials

TF96-96 Thermal Overload Relay

The representative product is TF96-96 Thermal Overload Relay which weighs 0.644 kg including its installed accessories, paper documentation and packaging.

TF96-96 Thermal Overload Relay				
Materials	**Name**	**IEC 62474 MC**	**[g]**	**%**
Metals	Cu and Cu Alloys	M-121	184.5	28.6%
	Stainless Steel	M-100	55.1	8.6%
	Steel	M-119	41.6	6.5%
Plastics	PolyButyleneTerephthalate	M-261	141.0	21.9%
	Polyamide	M-258	72.6	11.3%
	Polycarbonate	M-254	2.6	0.4%
	Unsaturated Polyester	M-301	2.5	0.4%
	Polyphenylenesulfide (PPS)	M-263	0.8	0.1%
	Polyethylene	M-251	0.2	<0.1%
Others	Paper/Cardboard	M-341	143.1	22.2%
Total			644.00	100.0%

Table 2: Weight of materials TF96-96 Thermal Overload Relay

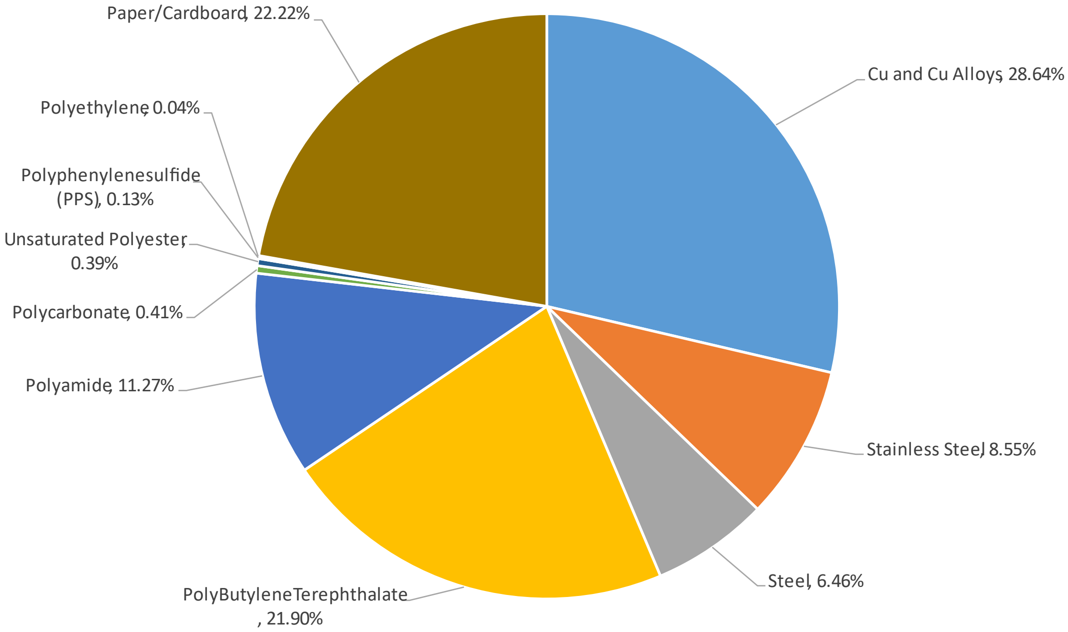

Figure 1: Composition of TF96-96 Thermal Overload relay

Packaging for reference product TF96-96 weighs 119.99 g, with the following substance composition:

Material	Unit	TF96-96
Corrugated Cardboard	g	120.0

Table 3: Weight of packaging materials TF96-96 Thermal Overload Relay

No cut-off criteria have been applied to the analysis of the product and its packaging. Additional packaging for semifinished products along the supply chain haven't been considered.

LCA background information

Functional unit and Reference Flow

The functional unit is the reference unit used to quantify the performance of the service delivered by a product to the user. The main purpose of the functional unit is to provide a reference to which inputs and outputs are related in the LCA.

Switch on and off during 20 years electrical power supply of a downstream installation with an electrical and/or mechanical control. The functional unit is characterized by control circuit voltage Uc =24V, 60V, 125V, 250V, a power circuit voltage Up and a maximum allowed intensity by the power circuit Ip.

Thermal Overload Relay	TF96-96
U_p = Rated operational Voltage (V)	690
I_p = Rated operational Current (A)	96

Table 4: Functional unit TF96-96 Thermal Overload Relay

The Reference Flow of the study is a TF96-96 Thermal Overload Relay (including its packaging and accessories) with mass described in chapter 1.3, table 2 & 3.

System boundaries and life cycle stages

The life cycle of the Thermal Overload Relay, an EEPS (Electronic and Electrical Products and Systems), is a “from cradle to grave” analysis and covers the following main life cycle stages: manufacturing, including the relevant acquisition of raw material, preparation of semi-finished goods, etc. and processing steps; distribution; installation, including the relevant steps for the preparation of the product for use; use including the required maintenance steps within the RSL (reference service life of the product) associated to the reference product; end-of-life stage, including the necessary steps until final disposal or recovery of the product system.

The following table shows the stages of the product life cycle and the information stages according to EN 50693:2019 [3] for the evaluation of electronic and electrical products and systems.

Manufacturing	Distribution	Installation	Use	End-of-Life (EoL)
Acquisition of raw materials Transport to manufacturing site Components/parts manufacturing Assembly Packaging EoL treatment of generated waste	Transport to distributor/ logistic center Transport to place of use	Installation EoL treatment of generated waste (packaging)	Usage Maintenance	Deinstallation Collection and transport EoL treatment

Table 5: Phases for the evaluation of construction products according to EN50693:2019 [3].

Temporal and geographical boundaries

The ABB component suppliers are sourced all over the world. All primary data collected are from 2022, which is a representative production year. Secondary data are also representative for this year, as provided by ecoinvent [6].

The selected ecoinvent [6] processes in the LCA model have a global representativeness, due to the unclear origin of each component. In this way, a conservative approach has been adopted.

Boundaries in the life cycle

As indicated in the PCR capital goods such as buildings, machinery, tools and infrastructure, the packaging for internal transport which cannot be allocated directly to the production of the reference product, may be excluded from the system boundary.

Infrastructures, when present, such as processes deriving from the ecoinvent [6] database have not been excluded.

Data quality

In this PEP, both primary and secondary data are used. Site specific foreground data have been provided by ABB. Main data sources are the bill of materials & drawings which are available on the ERP (SAP) & Windchill. For all processes for which primary are not available, generic data originating from the ecoinvent database [6], allocation cut-off by classification, are used. The ecoinvent database available in the SimaPro software [7] is used for the calculations.

The data quality characterized by quantitative and qualitative aspects, is presented in Appendix 1. Each data quality parameter has been rated according to DQR tables from Chapter 7.19.2.2 of the Product Environmental Footprint Guide v.6.3 to give an indication of geography, technology, and temporal representativeness.

Environmental impact indicators

The information obtained from the inventory analysis is aggregated according to the effects related to the various environmental issues. According to "PCR-ed4-EN-2021 09 06" and EN 50693 [3] the environmental impact indicators must be determined using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019 [8].

PCR-ed4-EN-2021 09 06 and the EN 50693:2019 [3] standard establish four indicators for climate change: Climate change (total) which includes all greenhouse gases; Climate change (fossil fuels); Climate change (biogenic) which includes the emissions and absorption of biogenic carbon dioxide and biogenic carbon stored in the product; Climate change (land use) - land use and land use transformation. Other indicators as per the PCR[1].

Allocation rules

Allocation coefficients are based on the labor hours required to produce one TF96-96 relay. Total electrical energy consumption for the year 2022 is divided by total labor hours in the year 2022 to calculate average per hour energy consumption of the total factory.

Limitations and simplifications

Raw materials life cycle stage includes the extraction of raw materials as well as the transport distances to the manufacturing suppliers. These distances are assumed to be 1000 km assuming no specific data available (PCR-ed4-EN-2021_09_06, ch 2.5.3). This distance has been added to the one already included in the market processes used for the model, as a result of a conservative choice made by the LCA operators.

Surface treatments like galvanizing, silver plating as well as their related transport processes (back and forth from the finishing suppliers) have been considered in the LCA model. Scraps for metal working and plastic processes are included when already defined in Ecoinvent [6].

The only limitations and simplifications applied to this study are listed in the following table.

Category	Description
Packaging	An average packaging content of 5% of the mass of the reference equipment has been considered as follow- Wood 50%, Cardboard 40%, Low density polyethylene 10%.
Tranports	Specific transport parameters along the entire supply chain of the reference products have been considered as representative for all the products covered by the study
MU Emissions	Impacts related to the production, transportation and installation of capital goods (buildings, infrastructure, machinery, internal transport packaging) and general operations (staff travel, marketing and communication actions) that cannot be directly allocated to products are excluded from the LCA study.

Table 6: Limitation and simplification used in each LCA stage

Energy Models

LCA Stage	EN 15804:2012 +A2:2019 module	Energy model	Notes
Raw material extraction and processing	A1-A2	Electricity, {GLO}| market group for | Cut-off/ Electricity, {RoW}| market group for | Cut-off	Based on materials and supplier's locations
Manufacturing	A3	ABB Green Mix Low Voltage	Specific Energy model for ABB Xinhui, China manufacturing plant, 100% renewable
Installation (Packaging EoL)	A5	Electricity, {GLO}| market group for | Cut-off	
Use Stage	B1	Electricity, [country]x | market for | Cut-off, S	Low voltage, based on 2022 country sales mix
EoL	C1-C4	Electricity, {GLO}| market group for | Cut-off	

Table 7: Energy models used in each LCA stage

** Please refer the use phase for further description

Inventory analysis

In this PEP, both primary and secondary data are used. Site specific foreground data have been provided by ABB. For data collection, Bills of Material (BOM) extracted from ABB's internal SAP and Windchill ERP were used. They are a list of all the components and assemblies that constitute the finished product, organized by hierarchy level. Each item is matched with its code, quantity, weight and supplier. The BOMs were then processed, adding material, surface area, volume and weight data, taken from technical drawings/datasheets. Finally, the manufacturing process and surface treatment were assigned, according to information provided by R&D personnel. Road distances between the suppliers and ABB were calculated using Google Maps, and marine distances using Distances & Time (Searates).

All primary data collected from ABB are from 2022, which was a representative production year. The ecoinvent cut-off by classification system processes [6] are used to represent the LCA model

To improve both the inventory and modelling phase of the product, a specific modular dataset framework has been adopted. Raw materials and Manufacturing processes datasets from Ecoinvent database [6] have been clustered and listed inside two distinct mater data tables ABB Raw Materials and ABB Materials & Processes. Data used in the analysis is not older than 10 years.

Manufacturing stage

TF65/TF96 Thermal Overload Relays are composed of a multitude of components, all of which are made from of numerous materials. Most of the inputs to the products' manufacturing stage are already produced component parts.
All the TF65/TF96 Thermal Overload Relays components have been modelled according to their specific raw materials and manufacturing processes.

The single use packaging as well as paper documentation are also included in the analysis in the manufacturing stage. ABB receives packaged product from supplier, sorts, repacks and delivers to the customer according to the orders.

Most of the inputs to the products' manufacturing stage are already produced component parts from the supply chain.

The entire supplier's network has been modelled with the calculation of each transportation stage, from the first manufacturing supplier to the next.

All the distances from the last subassembly suppliers' factories to the ABB facility have been calculated.
The complete energy mix has been modeled considering the GO on energy origins provided to ABB for the year 2022.

Distribution

The transport distances from ABB manufacturing plant to the distribution centers (regional distribution centers / local sales organizations) have been calculated considering the specific 2022 sales mix data for TF65/TF96 Thermal Overload Relay cluster (SAP ERP sales data as a source). An additional Considered 1000km additional distance as per the PSR.

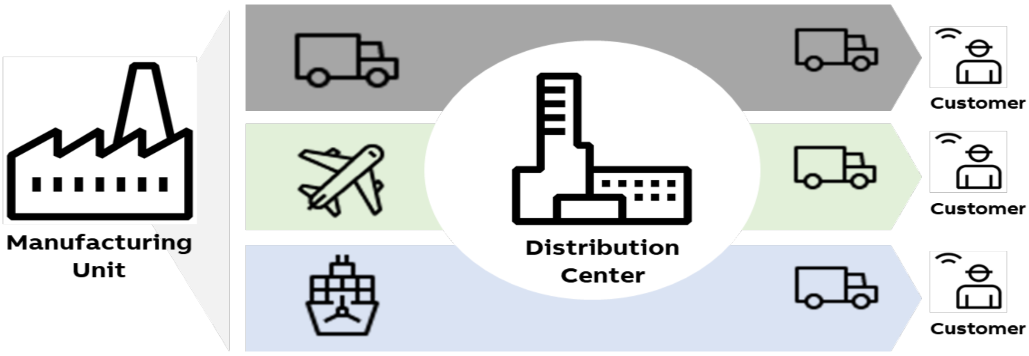

Figure 2: Distribution methodology.

Installation

The installation phase only implies manual activities, and no energy is consumed. This phase also includes the disposal of the packaging of the TF65/TF96 Thermal Overload Relays.

For the disposal of the packaging after installation of the product at the end of its life, a transport distance of 1000 km (according to PCR [1]) was assumed.

The actual disposal site is unknown and is managed by the customer. The disposal scenario of the packaging was calculated based on the latest China average data for 2022 available.

Use

Use and maintenance are modelled according to the PCR [1].

During the use phase, TF65/TF96 Thermal Overload Relays dissipate some electricity due to power losses. They are calculated according to the data provided in the catalogue of the TF65/TF96 Thermal Overload Relays and following the PCR [1] & PSR [2] rules:

Parameters		
Iu	[A]	96
Iu	[%]	30
h/year	[h]	8760
RSL	[years]	20
Time operating coefficient	[%]	30

Table 8: Use phase parameters

The formula for the calculation of the electricity consumed is shown below and it is described as follows, where P_{use} is the power consumed by the switch at a given value of current:

$$E_{use}\ [kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000}$$

The above calculations have been performed according to the number of poles (3) on which relevant current flows during use phase.

The Energy model used for this phase has been modeled based on the 2022 actual sales mix data (SAP ERP sales data as a source). From Ecoinvent [6] database, the low voltage electricity country mix for each country$_{(x)}$ has been selected with its respective percentage on the total sales mix (Electricity, low voltage [CN] | market for | Cut-off, S).

Since no maintenance happens during the use phase, the environmental impacts linked to this procedure have been considered as null in the analysis.

End of life

The end-of-life stage is modelled according to PCR [1] and IEC/TR 62635 [9]. The percentages for end-of-life treatments of materials are taken from IEC/TR 62635 [9].

Since no specific data is available, the transport distances from the place of use to the place of disposal are assumed to be 1000 km (local/domestic transport by lorry, according to PCR [1]).

Environmental impacts

The following table show the environmental impact indicators of the life cycle of a single TF96-96 Thermal Overload Relay, as indicated by PCR [1] and EN 50693:2019 [3]. The indicators are divided into the contribution of the processes to the different stages (manufacturing, distribution, installation, use and end-of-life).

Impact category	Unit	Total	Manuf	Distr	Install	Use	EoL
GWP-total	kg CO2 eq	3.63E+01	4.52E+00	4.11E+00	2.07E-01	2.72E+01	2.35E-01
GWP-fossil	kg CO2 eq	3.55E+01	4.58E+00	4.11E+00	1.22E-01	2.65E+01	2.24E-01
GWP-biogenic	kg CO2 eq	7.27E-01	-6.86E-02	8.62E-04	8.53E-02	6.99E-01	1.06E-02
GWP-luluc	kg CO2 eq	6.39E-02	6.08E-03	3.53E-04	5.94E-05	5.72E-02	1.98E-04
ODP	kg CFC11-eq	3.06E-06	2.70E-06	6.32E-08	2.00E-09	2.96E-07	1.56E-09
AP	mol H+ eq	2.09E-01	8.63E-02	1.77E-02	5.29E-04	1.03E-01	1.12E-03
EP-freshwater	kg P eq	2.64E-02	7.01E-03	6.09E-05	9.76E-06	1.93E-02	5.42E-05
EP-marine	kg N eq	3.60E-02	8.99E-03	7.15E-03	1.96E-04	1.91E-02	5.30E-04
EP-terrestrial	mol N eq	3.58E-01	1.01E-01	7.67E-02	2.08E-03	1.76E-01	2.39E-03
POCP	kg NMVOC eq	1.16E-01	2.84E-02	2.41E-02	7.41E-04	6.21E-02	7.75E-04
ADP-m&m	kg Sb eq	4.57E-03	4.35E-03	9.86E-07	3.22E-07	2.17E-04	1.92E-07
ADP-fossil	MJ	5.27E+02	6.13E+01	5.35E+01	1.73E+00	4.08E+02	2.25E+00
WDP	m3 of equiv. depriv.	6.58E+00	7.21E-01	9.30E-02	1.06E-02	5.74E+00	2.09E-02
PENRE	MJ	5.25E+02	5.94E+01	5.35E+01	1.73E+00	4.08E+02	2.25E+00
PENRM	MJ	1.91E+00	1.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	5.27E+02	6.13E+01	5.35E+01	1.73E+00	4.08E+02	2.25E+00
PERE	MJ	8.06E+01	1.04E+01	1.83E-01	2.22E-02	6.98E+01	2.05E-01
PERM	MJ	1.42E+00	1.42E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	8.20E+01	1.18E+01	1.83E-01	2.22E-02	6.98E+01	2.05E-01
SM	kg	1.11E-01	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PET	MJ	6.09E+02	7.31E+01	5.37E+01	1.75E+00	4.78E+02	2.46E+00
FW	m3	2.75E-01	6.16E-02	3.31E-03	3.38E-04	2.09E-01	7.90E-04
HWD	kg	1.64E-03	2.24E-04	3.62E-04	1.09E-05	1.04E-03	7.18E-06
N-HWD	kg	3.57E+00	1.30E+00	1.19E-01	1.51E-01	1.77E+00	2.33E-01
RWD	kg	1.54E-03	6.34E-05	3.84E-06	3.81E-07	1.47E-03	2.81E-06
CfR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MfR	kg	5.05E-01	8.18E-02	0.00E+00	6.60E-02	0.00E+00	3.57E-01
MfER	kg	6.42E-02	0.00E+00	0.00E+00	5.40E-02	0.00E+00	1.03E-02
EN	MJ by energy vector	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Efp	disease inc.	1.01E-06	4.02E-07	4.41E-08	1.22E-08	5.34E-07	1.84E-08
IrHH	kBq U-235 eq	6.32E+00	2.51E-01	1.74E-02	1.60E-03	6.04E+00	1.14E-02
ETX FW	CTUe	1.73E+02	9.82E+01	2.75E+01	1.09E+00	4.51E+01	8.12E-01
HTX CE	CTUh	3.16E-08	2.23E-08	4.48E-10	5.57E-11	8.53E-09	2.75E-10
HTX N-CE	CTUh	3.33E-06	2.89E-06	5.00E-08	1.86E-09	3.75E-07	1.68E-08
IrLS	Pt	1.39E+02	5.89E+01	4.27E+00	1.74E+00	7.24E+01	1.50E+00

Table 9: Impact indicators for TF96-96 Thermal Overload Relay

Impact category	Unit	TF96-96
Biogenic Carbon content of the product	kg	0.01
Biogenic Carbon content of the associated packaging	kg	0.0343

Table 10: Inventory flow other indicators

Environmental impact indicators

GWP-total	Global Warming Potential total (Climate change)
GWP-fossil	Global Warming Potential fossil
GWP-biogenic	Global Warming Potential biogenic
GWP-luluc	Global Warming Potential land use and land use change
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential
EP-freshwater	Eutrophication potential - freshwater compartment
EP-marine	Eutrophication potential - fraction of nutrients reaching marine end compartment
EP-terrestrial	Eutrophication potential -Accumulated Exceedance
POCP	Formation potential of tropospheric ozone
ADP-m&m	Abiotic Depletion for non-fossil resources potential
ADP-fossil	Abiotic Depletion for fossil resources potential
WDP	Water deprivation potential

Resource use indicators

PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw material
PERM	Use of renewable primary energy resources used as raw material
PERT	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material
PNERM	Use of non-renewable primary energy resources used as raw material
PENRT	Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)
PET	Total use of primary energy in the lifecycle

Secondary materials, water and energy resources

SM	Use of secondary materials
RSF	Use of renewable secondary fuels
NRSF	Use of non-renewable secondary fuels
FW	FW: Net use of fresh water

Waste category indicators

HWD	Hazardous waste disposed
N-HWD	Non-hazardous waste disposed
RWD	Radioactive waste disposed

Output flow indicators

CfR	Components for reuse
MfR	Materials for recycling
MfER	Materials for energy recovery
EN	Exported energy

Other indicators

Efp	Emissions of Fine particles
IrHH	Ionizing radiation, human health
ETX FW	Ecotoxicity, freshwater
HTX CE	Human toxicity, carcinogenic effects
HTX N-CE	Human toxicity, non-carcinogenic effects
IrLS	Impact related to Land use / soil quality

Extrapolation for Homogeneous environmental family

This PEP covers different build configurations than representative product. All the analyzed configurations have the same main functionality, product standards and manufacturing technology.

The different life cycle stages can be extrapolated to other products of the same homogeneous environmental family by applying a rule of proportionality to the parameters in the following tables, divided by different life cycle stages.

LCA Phase: Manufacturing

Product	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-minerals & metals	ADP-fossil	WDP
TF65-28/TF65-28B	0.64	0.65	1.10	0.69	0.84	0.62	0.59	0.61	0.59	0.62	0.44	0.65	1.22
TF65-33/TF65-33B	0.64	0.64	1.10	0.68	0.84	0.61	0.58	0.61	0.59	0.61	0.44	0.65	1.21
TF65-40/TF65-40B	0.64	0.65	1.10	0.69	0.84	0.62	0.59	0.61	0.59	0.62	0.44	0.66	1.22
TF65-47/TF65-47B	0.62	0.62	1.13	0.66	0.84	0.55	0.52	0.58	0.55	0.57	0.42	0.63	1.11
TF65-53/TF65-53B	0.64	0.65	1.09	0.69	0.84	0.62	0.59	0.61	0.59	0.62	0.44	0.65	1.23
TF65-60/TF65-60B	0.74	0.75	1.07	0.76	0.86	0.66	0.67	0.74	0.72	0.72	0.74	0.76	0.69
TF65-67/TF65-67B	0.75	0.75	1.05	0.77	0.86	0.68	0.70	0.75	0.73	0.73	0.74	0.76	0.73
TF96-51/TF96-51B	0.99	0.99	1.01	0.99	1.00	0.97	0.97	0.99	0.98	0.98	0.99	1.00	0.95
TF96-60/TF96-60B	1.00	1.00	1.00	0.99	1.00	0.98	0.98	0.99	0.99	0.99	0.99	1.00	0.97
TF96-68/TF96-68B	0.99	0.99	1.01	0.98	1.00	0.95	0.95	0.98	0.97	0.97	0.99	0.99	0.92
TF96-78/TF96-78B	0.99	0.99	1.02	0.98	1.00	0.95	0.95	0.98	0.97	0.98	0.99	0.99	0.92
TF96-87/TF96-87B	1.00	1.00	1.01	0.99	1.00	0.97	0.97	0.99	0.99	0.99	0.99	1.00	0.95
TF96-96/TF96-96B	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 11: Extrapolation factors for Manufacturing stage

Reference product: TF96-96 Thermal overload Relay

LCA Phase: Distribution

Products	Factors
TF65-28/TF65-28B	0.77
TF65-33/TF65-33B	0.76
TF65-40/TF65-40B	0.77
TF65-47/TF65-47B	0.74
TF65-53/TF65-53B	0.77
TF65-60/TF65-60B	0.77
TF65-67/TF65-67B	0.77
TF96-51/TF96-51B	0.99
TF96-60/TF96-60B	0.99
TF96-68/TF96-68B	0.98
TF96-78/TF96-78B	0.99
TF96-87/TF96-87B	0.99
TF96-96/TF96-96B	1.00

Table 12: Extrapolation factors for Distribution stage
Reference product: TF96-96 Thermal overload Relay

LCA Phase: Installation

Installation phase impacts are common across all variants of the Thermal Overload Relays.

LCA Phase: Use

Products	I [A]	LCA Phase	Factors
TF65-28/B	28	Use	0.84
TF65-33/B	33		1.03
TF65-40/B	40		0.98
TF65-47/B	47		0.99
TF65-53/B	53		0.99
TF65-60/B	60		0.92
TF65-67/B	67		0.93
TF96-51/B	51		1.17
TF96-60/B	60		1.29
TF96-68/B	68		1.25
TF96-78/B	78		1.05
TF96-87/B	87		1.07
TF96-96/B	96		1.00

Table 13: Extrapolation factors for Use phase

Reference product: TF96-96 Thermal overload Relay

LCA Phase: End of Life

Product	GWP-total	GWP-fossil	GWP-biogenic	GWP-luluc	ODP	AP	EP-freshwater	EP-marine	EP-terrestrial	POCP	ADP-minerals & metals	ADP-fossil	WDP
TF65-28/TF65-28B	0.69	0.68	0.89	0.65	0.70	0.66	0.65	0.73	0.68	0.69	0.72	0.68	0.67
TF65-33/TF65-33B	0.68	0.68	0.88	0.64	0.70	0.65	0.63	0.73	0.67	0.68	0.71	0.67	0.66
TF65-40/TF65-40B	0.69	0.68	0.88	0.65	0.70	0.66	0.64	0.73	0.68	0.69	0.72	0.68	0.67
TF65-47/TF65-47B	0.63	0.62	0.85	0.57	0.65	0.59	0.56	0.70	0.62	0.63	0.68	0.61	0.61
TF65-53/TF65-53B	0.69	0.69	0.87	0.65	0.70	0.66	0.65	0.73	0.68	0.69	0.72	0.68	0.68
TF65-60/TF65-60B	0.68	0.67	0.90	0.63	0.69	0.64	0.62	0.73	0.67	0.68	0.72	0.66	0.66
TF65-67/TF65-67B	0.70	0.69	0.91	0.66	0.71	0.67	0.65	0.74	0.69	0.70	0.73	0.69	0.68
TF96-51/TF96-51B	0.97	0.97	0.97	0.96	0.97	0.96	0.96	0.99	0.97	0.97	0.98	0.97	0.97
TF96-60/TF96-60B	0.98	0.98	0.97	0.98	0.98	0.98	0.98	0.99	0.98	0.98	0.99	0.98	0.98
TF96-68/TF96-68B	0.96	0.96	0.96	0.94	0.96	0.95	0.94	0.98	0.95	0.96	0.97	0.95	0.95
TF96-78/TF96-78B	0.96	0.96	0.98	0.94	0.97	0.95	0.94	0.98	0.96	0.96	0.97	0.95	0.95
TF96-87/TF96-87B	0.97	0.97	0.99	0.96	0.98	0.97	0.96	0.99	0.97	0.98	0.98	0.97	0.97
TF96-96/TF96-96B	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 14: Extrapolation factors for EOL Phase

Reference product: TF96-96 Thermal overload Relay

Additional environmental information

According to the waste treatment scenario calculation in Simapro [7], based on the recycling rate in the technical report IEC/TR 62635 Edition 1.0 [9] Table D.6, the following recyclability potentials were calculated. The recyclability potential is calculated based on the product weight (excluding packaging).

	TF96-96
Recyclability potential	93.3%

Table 15: Recyclability potential of TF96-96 Thermal overload Relay

References

[1] PCR “PEP-PCR-ed4-EN-2021_09_06” - Product Category Rules for Electrical, Electronic and HVAC-R Products (published: 6th September 2021)

[2] PSR “PSR-0005-ed3-EN-2023 06 06” - SPECIFIC RULES FOR Electrical switchgear and control gear Solutions

[3] EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems

[4] ISO 14040:2006 - Environmental management -Life cycle assessment - Principles and framework

[5] ISO 14044:2006 - Environmental management - Life cycle assessment - Requirements and guidelines

[6] ecoinvent v3.9.1 (2023). ecoinvent database version 3.8 - (https://ecoinvent.org/)

[7] SimaPro Software version 9.5.0.1 - PRé Sustainability

[8] UNI EN 15804:2012+A2:2019: Sustainability of constructions - Environmental product declarations (September 2019).

[9] IEC/TR 62635 - Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment - Edition 1.0 2012-10

[10] https://www.ecosystemspa.com/

[11] 1SAC200248H0001_Thermal overload Relay TF96-96_BOM_Process

[12] 1SAC200247H0001_ Thermal overload Relay TF96-96_LCA Data