Bundesamt für Energie
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Swiss Federal Office of Energy

Program Electricity

Label for UPS Systems

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1. INTRODUCTION

Uninterruptible Power Supply (UPS) systems are constructed using a variety of different technologies. Depending on method of construction and mode of operation, their quality as load and as supply system and their energy efficiency varies. It is difficult to compare different UPS systems because so far no standard criteria for comparison have been established.

The Swiss Federal Office of Energy (SFOE) commissioned the project „Parameteridentifikation und Messverfahren für USV-Anlagen" [1] and created a basis for comparing UPS systems. The result of this project was a standardised method for determining the parameters of UPS Systems, including a definition of measurement procedures in order to determine the quality of UPS systems and their energy efficiency.

This definition is the basis for this proposed labelling method for UPS Systems. The label will permit the standardised comparison of UPS Systems.

2. GOALS, CONSTRAINTS AND TECHNICAL BASIS

2.1. GOALS

The proposed label for UPS systems contains information about the quality of the systems and their energy efficiency. The introduction of a standardised label for UPS systems has the following goal:

Labelling will permit comparison of the relative quality and energy efficiency of UPS systems which will, in turn, permit planning engineers to improve selection and design and operators to improve the daily operation of UPS systems.

2.2. CONSTRAINTS

The following constraints must be considered in designing labelling of UPS systems:

- The label will have to be approved by the manufacturers and distributors of UPS systems, as well as by their operators and planning engineers.
- The label will allow the manufacturers and distributors a standardised and therefore comparable method for declaring the parameters and performance specifications of their UPS systems.
- The use of the label will be voluntary but the Swiss Federal Office of Energy is interested in very wide use of the label.
- Since the proposed labelling of UPS systems is intended to be used throughout Europe, the design of the label should conform to EU standards. The Swiss Federal Office of Energy will urge European commissions to promote the adoption of the labelling method throughout the EU.

2.3. TECHNICAL BASIS

The proposed labelling is based upon the results of the project „Parameteridentifikation und Messverfahren für USV-Anlagen“ [1]. This project was performed during the years 1997/98 by order of the Swiss Federal Office of Energy. An essential outcome of this project is the Quality-/Energy-Matrix (Q/E-Matrix: Appendix 1).

The Q/E-Matrix shows the relationship between the process-oriented quality criteria and the energy relevant parameters and provides information about process-oriented quality requirements such as:

- reliability of the power supply,
- filtering of net disturbances,
- improvement of the power factor and
- reduction of harmonic distortion

Furthermore the Q/E-Matrix shows

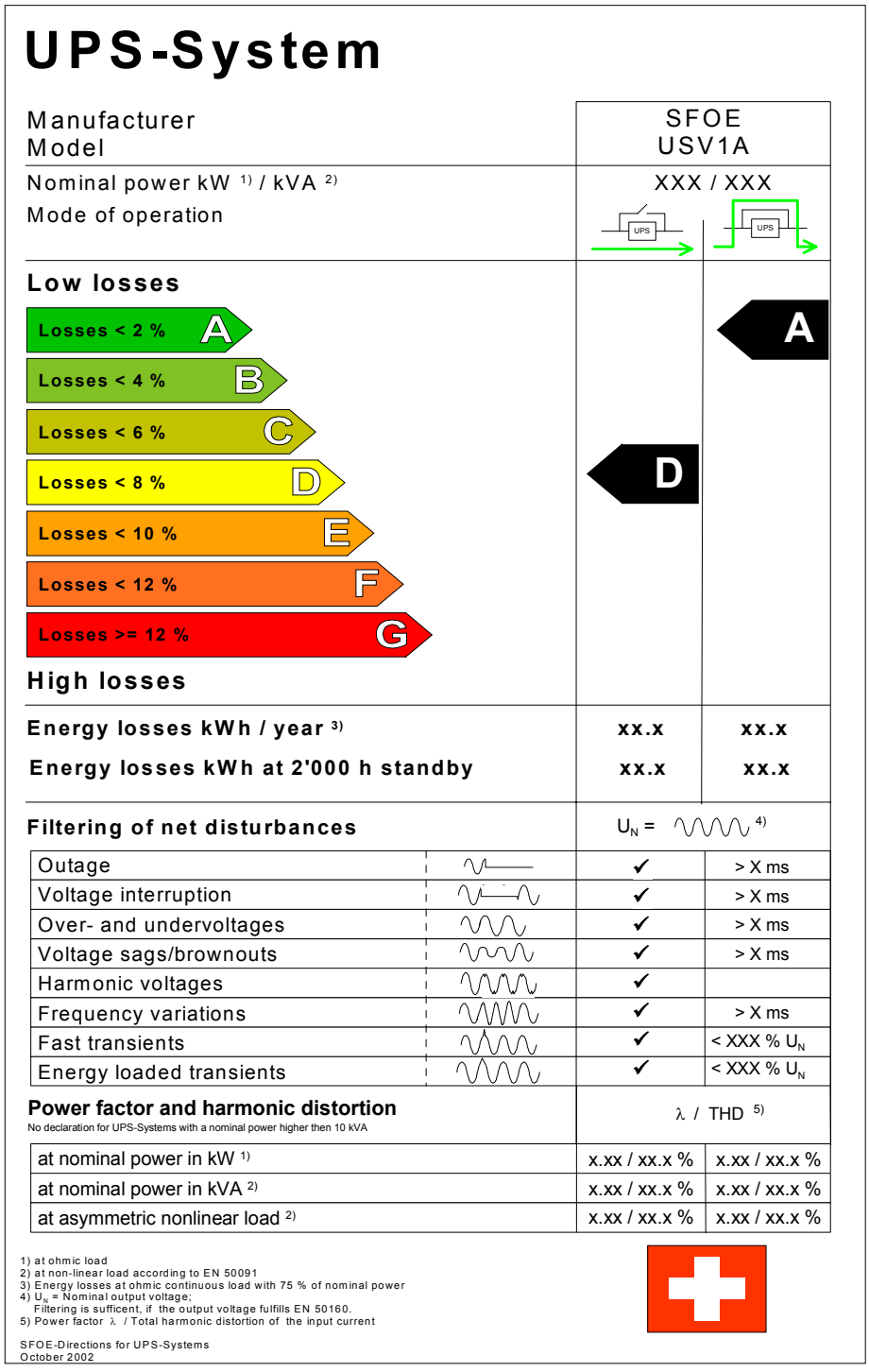
- energy losses during normal operation and
- energy losses at standby, that means at no load

In addition, the project „Parameteridentifikation und Messverfahren für USV-Anlagen“ defines a standardised procedure to determine the parameters for the Q/E-Matrix.

3. DESIGN OF THE LABEL FOR UPS SYSTEMS

3.1. FORMAT OF THE LABEL

The label for UPS Systems has been designed to match the existing EU-Label for other electric appliances. This approach was chosen to facilitate the application of the label for UPS systems throughout Europe.



UPS-System

Manufacturer Model	SFOE USV1A	
Nominal power kW [1] / kVA [2] Mode of operation	XXX / XXX	
Low losses		
Losses < 2 % A		A
Losses < 4 % B		
Losses < 6 % C		
Losses < 8 % D	D	
Losses < 10 % E		
Losses < 12 % F		
Losses >= 12 % G		
High losses		
Energy losses kWh / year [3]	xx.x	xx.x
Energy losses kWh at 2'000 h standby	xx.x	xx.x
Filtering of net disturbances	U_N = [4]	
Outage	✓	> X ms
Voltage interruption	✓	> X ms
Over- and undervoltages	✓	> X ms
Voltage sags/brownouts	✓	> X ms
Harmonic voltages	✓	
Frequency variations	✓	> X ms
Fast transients	✓	< XXX % U_N
Energy loaded transients	✓	< XXX % U_N
Power factor and harmonic distortion No declaration for UPS-Systems with a nominal power higher then 10 kVA	λ / THD [5]	
at nominal power in kW [1]	x.xx / xx.x %	x.xx / xx.x %
at nominal power in kVA [2]	x.xx / xx.x %	x.xx / xx.x %
at asymmetric nonlinear load [2]	x.xx / xx.x %	x.xx / xx.x %

1) at ohmic load
2) at non-linear load according to EN 50091
3) Energy losses at ohmic continuous load with 75 % of nominal power
4) U_N = Nominal output voltage;
Filtering is suffcient, if the output voltage fulfills EN 50160.
5) Power factor λ / Total harmonic distortion of the input current

SFOE-Directions for UPS-Systems
October 2002

The label for UPS systems provides information about the **energy efficiency** and the **quality** of the system. Furthermore, it considers the possible **modes of operation**. The quality statement is based on the process-oriented functions of the system. This prevents comparing the different technologies used in UPS systems.

The parameters shown on the label represent a summary of the key parameters described in the Quality-/Energy-Matrix. The detailed measuring procedure to determine the data of the Q/E-Matrix is described in the documentation of the project „Parameteridentifikation und Messverfahren von USV-Anlagen“ [1].

3.2. DESCRIPTION OF THE INFORMATION SHOWN ON THE LABEL

The label for UPS Systems contains the following information:

- Manufacturer / Model
- Nominal power
- Mode of operation
- Losses
- Energy losses per year
- Filtering of net disturbances
- Power factor and harmonic distortion[1]

These items are explained in more detail below.

3.2.1. Manufacturer / Model

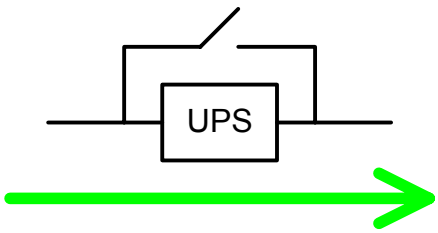
The manufacturer and the type of UPS system are listed.

3.2.2. Nominal power

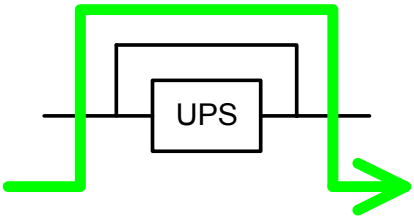
The nominal power in kW at purely resistive load and the nominal power in kVA using a non-linear load according to EN 50091 are shown. Both values are shown for continuous operation. If continuous operation at nominal power is not possible, this must also be declared.

3.2.3. Mode of operation

Possible modes of operation are shown, i.e.: “Normal operation through UPS-Path” and/or “Normal operation through bypass”.



„Normal operation through UPS-Path“



„Normal operation through bypass“

[1] For UPS-Systems with a nominal power less than 10 kVA no declaration of the power factor and the harmonic distortion is required.

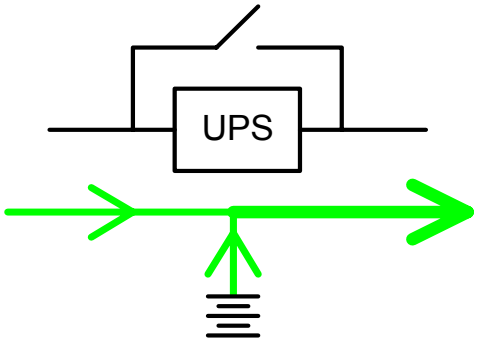
In mode "**Normal operation through UPS-Path,**" the connected load is supplied through the UPS-Path. In case of a disturbance of the UPS-Path, the power supplied to the load is switched to the bypass. As soon as the disturbance is repaired, the power supplying the load will be switched back to the UPS-Path after a period of stabilization.

In mode "**Normal operation through bypass**," the connected load is supplied through the bypass of the UPS System. For this mode of operation the following conditions have to be met:

- As a consequence of net disturbances the UPS System has to switch from the mode "through bypass" to the mode "through UPS-Path". Exceptions to this rule are two types of net disturbances: harmonic voltage distortion and transients.
- When a net disturbance causes the system to switch from the bypass to the UPS-path the interruption of power must not exceed 20 ms.
- During "Normal operation through bypass" the system is required to periodically perform an automatic test of the battery capacity and of the operation through the UPS-path.

UPS systems with passive stand-by operation supply the load during normal operation directly from the net. In case of a net disturbance these UPS systems switch to the UPS-Path. These UPS systems will be labelled like other systems in mode "Normal operation through bypass".

UPS systems with a reduced power of the rectifier in the UPS-Path have to declare this restriction at "Normal operation through UPS-Path" with the symbol below. With this type of UPS system the time during which it can supply nominal power through the UPS-Path is limited and depends on the capacity of the batteries.



„Normal operation through UPS-Path"
at UPS Systems with a reduced power
of the rectifier in the UPS-Path

3.2.4. Losses

The losses are to be determined with all the different types of loads described in the Q/E-Matrix. The losses shown on the label correspond to the maximum measured losses for the different types of loads.

For both modes of operation, "Normal operation through UPS-Path" and "Normal operation through bypass", the maximum losses are determined in a load 50 % to 100 % of nominal power. On the label only the corresponding range is indicated (A-G). If the mode of operation "Normal operation through bypass" is not possible no declaration will be made for this mode. This means that only the losses at the mode of operation "Normal operation through UPS-Path" are shown.

3.2.5. Energy losses per year

The yearly energy losses of the system are shown, i.e. the energy lost between input and output of the UPS system. The losses will be computed assuming a static resistive load of 75 % of nominal power over one year. Energy losses are to shown for both modes of operation.

In addition to the energy losses of a year the energy losses at 2'000 h standby operation are shown. Standby operation is equal with no load operation with U_{out} = 230 V and I_{out} = 0 A.

3.2.6. Filtering of net disturbances

This section of the label describes the capacity of the UPS system to protect the load against the net disturbances according to the Q/E-Matrix. This is shown for both modes of operation "Normal operation through UPS-path" and "Normal operation through bypass".

- Normal operation through UPS-path:
  The UPS system has to reduce net disturbances sufficiently enough such that the quality of the output-voltage conforms to EN 50160.
- Normal operation through bypass:
  When net disturbances occur, the UPS system has to switch from mode through bypass to mode through UPS-path. During this switchover a maximal interruption of the power supply of 20 ms is allowed. Exceptions to this requirement are harmonic voltage distortions and transient disturbances.
  The harmonic voltages cannot be filtered during "Normal operation through bypass".
  Transients also must be sufficiently reduced during "Normal operation through bypass" and may not lead to malfunctions of the UPS system itself. This means that a sufficient level of filtering has to be effective also in "Normal operation through bypass".

If one of the modes of operation is not possible the respective declarations are not applicable.

3.2.7. Power factor and harmonic distortion

The power factor and the harmonic distortion during "Normal operation through UPS-Path" and during "Normal operation through bypass" are declared.

For UPS Systems with nominal power over 10 kVA the power factor and the harmonic distortion must be shown on the label for the following loads:

- Purely resistive load at nominal power,
- non-linear load according to EN 50091 at nominal power,

asymmetric, non-linear load.

The declaration contains:

- The power factor λ at the input of the UPS System.
- The total harmonic distortion of the input current corresponding to the total of all harmonic input currents.

The individual harmonic currents of the input current are not shown on the label. The reason is the clarity of the label. The data of the individual harmonic current are contained in the current spectrum of the Q/E-Matrix.

The maximum acceptable harmonic currents of the input of a UPS system depend on the short circuit power of the network at the connecting point. The planning engineer has to cal-

culate the acceptable maximum values of the individual harmonic currents and of the total harmonic distortion according to the „Empfehlung für die Beurteilung von Netzrückwirkungen“ [2] of the Verband Schweizerischer Elektrizitätswerke (VSE-Empfehlung Nr. 2.72d-97).

In mode of operation “through bypass” it is only possible to reduce the power factor and the harmonic distortion caused by the load with filters that are connected to the input side of the UPS System. If such filters are necessary to allow a “Normal operation through bypass”, they have to be included measuring the losses.

4. BINDINGNESS OF THE LABEL

4.1. AWARDING THE LABEL

The proposed label for UPS systems will be awarded to manufacturers by Energy 2000 (E2000). The basis for the award is self-declaration of conformity to the proposed standards (proof of conformity). The label corresponds to a product specification and so the law against unfair competition is applied. It is sufficient for the manufacturer to measure each model of UPS system, i.e. it is not necessary to measure each individual UPS system.

4.2. REVIEW PROCESS

The declarations on the label are subject to verification by an independent accredited auditor. This means the data on the label must be verifiable for each individual UPS System. Any verification of the declarations on the label by an independent auditor needs to be performed according to the “Messverfahren für USV-Anlagen” [1].

Bibliography

[1]: Swiss Federal Office of Energy: Documentation of the project „Parameteridentifikation und Messverfahren für USV-Anlagen“

[2]: Verband Schweizerischer Elektrizitätswerke: „Empfehlungen für die Beurteilung von Netzrückwirkungen“ (VSE-Empfehlung Nr. 272d-97)

Appendix

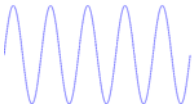
Appendix 1: Quality-/Energy-Matrix

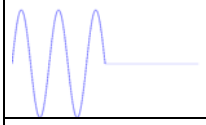
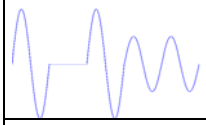
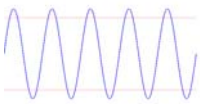
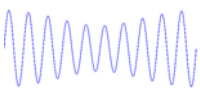
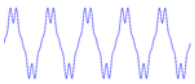
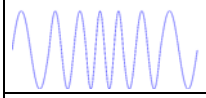
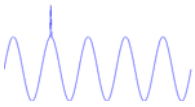
Swiss Federal Office of Energy

UPS Systems

Q/E-Matrix

Model:	**Nominal active power (P_{Nom}):**
Manufacturer:	**Nominal apparent power (S_{Nom}):**

Net voltage during normal operation (U_{NORM} according to EN 50160)		
	Voltage Frequency	230 V +/- 10 % 50 Hz +/- 1.0 %

Net disturbances (Input)	**Disturbance** (Measurement procedure) Range	**Filtering of net disturbances (Output)**			
		Normal operation through UPS Path		**Normal operation through bypass** (before net disturbance)	
		U_{NORM} o.k. ?	**Deviation of U_{NORM}**	**U_{NORM} o.k. ?**	**Deviation of U_{NORM}**
	**Outage** (Chap. 2) t_{UI} > 1 s	Yes/No		Yes/No	
	**Voltage interruption** (Chap. 4.1, 4.5 – 4.7) t_{UI} < 1 s	Yes/No		Yes/No	
	**Over- and undervoltages** (Chap. 3.1 – 3.4) Δ U_I = +/- 10 % Δ U_I = +/- 25 %	Yes/No		Yes/No	
	**Voltage sags / brownouts** (Chap. 4.1 – 4.4) Δ U_I = - 30 % Δ U_I = - 60 %	Yes/No		Yes/No	
	**Harmonic voltages** (Chap. 5) Distortion level class 3 according to IEC 61000-4-13	Yes/No		Yes/No	
	**Frequency variations** (Chap. 3.1; 3.5 – 3.7) Δ f_{IStep} = +/- 10 % Δ f_{ICont} = +/- 10 %	Yes/No		Yes/No	
	**Transients** (Chap. 6) Fast transients according to IEC 1000-4-4	Yes/No		Yes/No	
	Energy loaded transients according to IEC 1000-4-5	Yes/No		Yes/No	

Legend:

U_{NORM} Normal voltage according to EN 50160 (230 V +/- 10 %; 50 Hz +/- 1.0 %)

P_{Nom} Max. continuous nominal output power at linear ohmic load

S_{Nom} Max. continuous nominal output power at non-linear load according to EN 50091

Load:

50 % linear ohmic load

The transients are measured at 50 % linear ohmic load or at a load of maximum 16 A / phase at UPS-Systems with a power higher than 20 kVA

Swiss Federal Office of Energy

UPS Systems

Q/E-Matrix

Power factor and harmonic currents during normal operation at the input at 230 V
(Measurement procedure chap. 7)

Normal operation through UPS-Path			**Load at the output**
Power factor	**THD of the input current**	**Individual harmonic currents**	
λ =	k = %		at 100 % linear ohmic load (P_{Nnom})
λ =	k = %		at 100 % non-linear load according to EN 50091 (S_{Nom})
λ =	k = %		at maximum output current (Power factor λ =)
λ =	k = %		at 0-10 %, 50 %, 100 %, asymmetric non-linear load according to EN 50091

Normal operation through bypass			**Load at the output**
Power factor	**THD of the input current**	**Individual harmonic currents**	
λ =	k = %		at 100 % linear ohmic load (P_{Nnom})
λ =	k = %		at 100 % non-linear load according to EN 50091 (S_{Nom})
λ =	k = %		at maximum output current (Power factor λ =)
λ =	k = %		at 0-10 %, 50 %, 100 %, asymmetric non-linear load according to EN 50091

Losses and efficiency during normal operation (Input voltage U_I = 230 V +/- 10 %)
(Measurement procedure chap. 8)

Normal operation through UPS-Path

Power	**Losses (in W) and efficiency (in %) during normal operation through UPS-Path with**							
	Linear ohmic load		Non-linear load according to EN 50091		Maximum output current (λ =)		Asymmetric non-linear load according to EN 50091	
50 % Nom. power	W	%	W	%	------	------	W	%
75 % Nom. power	W	%	W	%	------	------	------	------
100 % Nom. power	W	%	W	%	W	%	------	------
Standby Losses:	W at U_{out} = 230 V and I_{out} = 0 A							

Normal operation through bypass

Power	**Losses (in W) and efficiency (in %) during normal operation through bypass with**							
	Linear ohmic load		Non-linear load according to EN 50091		Maximum output current (λ =)		Asymmetric non-linear load according to EN 50091	
50 % Nom. power	W	%	W	%	------	------	W	%
75 % Nom. power	W	%	W	%	------	------	------	------
100 % Nom. power	W	%	W	%	W	%	------	------
Standby Losses:	W at U_{out} = 230 V and I_{out} = 0 A							