Test Report issued under the responsibility of:

TEST REPORT
IEC 62368-1
Audio/video, information and communication technology equipment
Part 1: Safety requirements

Report Number .....:	E135494-A6005-CB-1
Date of issue.....:	2019-02-27
Total number of pages .....:	104
Applicant's name.....:	**TDK-LAMBDA UK LTD**
Address .....:	**KINGSLEY AVE** **ILFRACOMBE** **EX34 8ES UNITED KINGDOM**
Name of Test Laboratory preparing the Report .....:	UL VS Limited Unit 3 Horizon, Kingsland Business Park Wade Road, Basingstoke RG24 8AH, United Kingdom
Test specification:	
Standard .....:	IEC 62368-1:2014 (Second Edition)
Test procedure .....:	CB Scheme
Non-standard test method.....:	N/A
Test Report Form No.....:	IEC62368_1B
Test Report Form(s) Originator .....:	UL(US)
Master TRF.....:	2014-03

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results presented in this report relate only to the object tested.
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The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

Test Item description :	Power supply	
Trade Mark ..... :	TDK·Lambda	
Manufacturer ..... :	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM	
Model/Type reference ..... :	EFE400 or EFE-400, EFE400R or EFE-400R series (may be followed by characters as described in Model Differences).	
Ratings ..... :	100-240Vac nom, 45-440Hz, 6.1Arms Max, or, 133-318Vdc nom, 4.2Adc max	
Testing procedure and testing location:		
☐ CB Testing Laboratory:		
Testing location/ address ..... :		
☐ Associated CB Testing Laboratory:		
Testing location/ address..... :		
Tested by (name + signature).....:		
Approved by (name + signature).....:		
☐ Testing procedure: TMP/CTF Stage 1		
Testing location/ address..... :		
Tested by (name + signature).....:		
Approved by (name + signature).....:		
☐ Testing procedure: WMT/CTF Stage 2		
Testing location/ address..... :		
Tested by (name + signature).....:		
Witnessed by (name + signature).....:		
Approved by (name + signature).....:		
☒ Testing procedure: SMT/CTF Stage 3 or 4		
Testing location/ address..... :	TDK LAMBDA UK LTD, KINGSLEY AVENUE, ILFRACOMBE, DEVON. EX34 8ES. UNITED KINGDOM	
Tested by (name + signature).....:	N Marsh / Tester	

Approved by (name + signature) .....:	T Burgess / Approver	
Supervised by (name + signature) .....:	Mike Burns / Reviewer	

List of Attachments (including a total number of pages in each attachment):

National Differences (28 pages)
Enclosures (124 pages)

Summary of testing:

Unless otherwise indicated, all tests were conducted at TDK LAMBDA UK LTD, KINGSLEY AVENUE, ILFRACOMBE, DEVON. EX34 8ES. UNITED KINGDOM.

Tests performed (name of test and test clause):	**Testing Location:**
CLASSIFICATION OF ELECTRICAL ENERGY SOURCES (5.2, 5.7)	
DETERMINATION OF WORKING VOLTAGE (5.4.1.8)	
BALL PRESSURE TEST (5.4.1.10.3)	
ELECTRIC STRENGTH TEST (5.4.9)	
SAFEGUARDS AGAINST CAPACITOR DISCHARGE AFTER DISCONNECTION OF A CONNECTOR (5.5.2.2)	
RESISTANCE OF THE PROTECTIVE BONDING SYSTEM (5.6.6.2)	
PROSPECTIVE TOUCH VOLTAGE AND TOUCH CURRENT MEASUREMENT (5.7)	
INPUT TEST: POLYPHASE (B.2.5)	
NORMAL OPERATING CONDITIONS TEMPERATURE MEASUREMENT (B.2.6)	
SIMULATED ABNORMAL OPERATING CONDITIONS (B.3)	
SIMULATED SINGLE FAULT CONDITIONS (B.4)	
TRANSFORMER OVERLOAD (ANNEX G.5.3.3)	
ALTERNATIVE LOCKED-ROTOR OVERLOAD TEST FOR D.C. MOTORS (ANNEX G.5.4.6.3)	
LIMITED SHORT CIRCUIT TEST (ANNEX R.1, 5.6.4.1, 5.6.4.4, 5.6.5.1)	
STEADY FORCE TEST, 10 N (ANNEX T.2 , 5.4.2.6, 5.4.3.2, G.15.3.6)	

Summary of compliance with National Differences:

List of countries addressed: AU,NZ, JP, EU Group Differences, US,CA

☒ **The product fulfils the requirements of:** CSA/UL 62368-1 2nd Edition, EN 62368-1:2014 + A11:2017

Copy of Marking Plate - Refer to Enclosure titled Marking Plate for copy.

TEST ITEM PARTICULARS:	
Classification of use by	Skilled person
Supply Connection	AC Mains DC Mains ES3
Supply % Tolerance	+10%/-10% (AC)
Supply Connection – Type	mating connector
Considered current rating of protective device as part of building or equipment installation	20 A; building;
Equipment mobility	for building-in
Over voltage category (OVC)	OVC II
Class of equipment	Class I
Access location	N/A
Pollution degree (PD)	PD 2
Manufacturer's specified maximum operating ambient	70°C (de-rated output power by 2.5% per °C above 50°C) °C
IP protection class	IPX0
Power Systems	TN TT
Altitude during operation (m)	5000 m
Altitude of test laboratory (m)	2000 m or less
Mass of equipment (kg)	1kg max. kg
POSSIBLE TEST CASE VERDICTS:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement ..... :	P (Pass)
- test object does not meet the requirement ..... :	F (Fail)
TESTING:	
Date of receipt of test item..... :	2018-08-06 to 2018-10-01
Date (s) of performance of tests..... :	2018-08-16 to 2018-10-09
GENERAL REMARKS:	
"(See Enclosure #)" refers to additional information appended to the report. **"(See appended table)" refers to a table appended to the report.** **Throughout this report a ☐ comma / ☒ point is used as the decimal separator.**	
Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:	

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	☒ **Yes** ☐ **Not applicable**
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies) ..... :	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM PANYU TRIO MICROTRONICS CO LTD SHIJI INDUSTRIAL ESTATE DONGYONG NANSHA GUANGZHOU GUANGDONG 511453 CHINA TDK-LAMBDA CORP 2704-1 SETTAYA-MACHI NAGAOKA-SHI NIIGATA-KEN 940-1195 JAPAN

GENERAL PRODUCT INFORMATION:

Report Summary

All applicable tests according to the referenced standard(S) have been carried out.

Product Description

The EFE400 or EFE-400 and EFE400R or EFE-400R Series are switch mode power supplies for building into host equipment.

Model Differences

EFE400 or EFE-400 models as described below:

Units may be marked with a Product Code: U4x or Y4x where x may be any number of characters.

Unit Configuration Code (Description) may be prefixed by NS # (where # may be any number of characters indicating non- safety related model differences).

Unit Configuration Code:

EFE400x-a-bcde-f-g-hij

Where:

x = Nothing or J for Japanese models (may have non-safety differences)

a = Channel 1 Output Voltage: any voltage within the Adjustment Range for the Vout (nom) from the Output Table below, e.g. 12.8 for 12.8V output (12Vout nom), 24.6 for 24.6V output (24Vout nom).

b = CN for Open Frame with fan output, CU for U chassis with fan output, CC for U chassis and cover with fan output, EC for U chassis and cover with fan (temperature controlled).

c = M for molex input connector or equivalent, J for JST connector or equivalent.

d = D for dual fused input, FL for single fuse input in the Live Line.

e = S for Standard Leakage, L for Low Leakage, R for Reduced Leakage, T for Tiny Leakage.*

f = Nothing for horizontal output connector, V for vertical output connector.

g = Nothing for standard channel 1 output voltage, xD or xPD where D is for units with programmed negative load regulation, PD is for units with programmed positive load regulation, x is the voltage of the regulation in 100mVolts and is within the Output Adjustment range (example, 7D = 0.7V of negative load regulation, 24PD = 2.4V of positive load regulation).

hij = Three numbers from 0 to 9 which denotes various output voltage/current settings within the specified ranges of each output for a particular unit or blank for standard output settings. (may define non-safety related parameters/feature, e.g. reduced primary current limit, reduced OVP).

Output Parameters

Standard models:

Output Channel	Vout Nom.	Adjustment Range (V)	Output Current (A)	Maximum Power (W)
Channel 1	12	11.4 - 13.2*	33.33	400 (530**)
	24	22.8 - 26.4*	16.67	400 (530**)
Fan output (optional)	12	Fixed	0.25	3

Variations and limitations of use:

1. Maximum ambient 70°C (de-rating output power 2.5% per °C above 50°C).
2. * Can be adjusted at the factory only.
3. Maximum continuous power output 400W (excluding fan output).
4. ** Peak power for 10 seconds maximum, maximum rms power of 400Wrms.

EFE400R or EFE-400R models as described below:

Units may be marked with a Product Code: U4x or Y4x where x may be any number of characters.

Unit Configuration Code (Description :) may be prefixed by NS # (where # may be any number of characters indicating non- safety related model differences).

Unit Configuration Code:

EFE400Rx-a-bcde-km-f-g-hij

Where:

x = Nothing or J for Japanese models (may have non-safety differences)

a = Channel 1 Output Voltage: any voltage within the Adjustment Range for the Vout (nom) from the Output Table below.

b = CN for Open Frame with fan output, CU for U chassis with fan output, CC for U chassis and cover with fan output, EC for U chassis and cover with fan (temperature controlled), NN for open frame with no fan output.

c = M for molex input connector or equivalent, J for JST connector or equivalent.

d = D for dual fused input, FL for single fuse input in the Live Line.

e = S for Standard Leakage, L for Low Leakage, R for Reduced Leakage, T for Tiny Leakage.*

f = Nothing for horizontal output connector, V for vertical output connector.

g = Nothing for standard channel 1 output voltage, xD or xPD where D is for units with programmed negative load regulation, PD is for units with programmed positive load regulation, x is the voltage of the regulation in 100mVolts and is within the Output Adjustment range (example, 7D = 0.7V of negative load regulation, 24PD = 2.4V of positive load regulation).

hij = Three numbers from 0 to 9 which denotes various output voltage/current settings within the specified ranges of each output for a particular unit or blank for standard output settings. (may define non-safety related parameters/feature, e.g. reduced primary current limit, reduced OVP).

k = Y for or-ing device or N for none fitted.

m = E for enable or T for inhibit.

Output Channel	Vout Nom.	Adjustment Range (V)	Max Output Current (A)	Maximum Power (W)
Channel 1	48	47-50*	8.5	400 (470**)
Fan output (optional)	12	Fixed	0.25	3

Variations and limitations of use:

1. Maximum ambient 70°C (de-rating output power 2.5% per °C above 50°C).
2. * Can be adjusted at the factory only.
3. Maximum continuous power output 400W (excluding fan output).
4. ** Peak power for 10 seconds maximum, maximum rms power of 400Wrms.

Additional application considerations – (Considerations used to test a component or sub-assembly) -

Factory Production Note: Model EFE400 Series is produced at all three Factories noted on the CB Certificate. Model EFE400R Series is produced in the UK and China Factories noted on the CB Certificate but is not produced in the Factory located in Japan.

Cooling for units with customer supplied air (all except EC models):

The following method must be used for determining the safe operation of PSUs.

The components listed in the following table must not exceed the temperatures given. To determine the component temperatures the heating tests must be conducted in accordance with the requirements of IEC62368-1. Consideration should also be given to the requirements of other safety standards.

Test requirements include: PSU to be fitted in its end-use equipment and operated under the most adverse conditions permitted in the end-use equipment handbook/specification and which will result in the highest temperatures in the PSU. To determine the most adverse conditions consideration should be given to the end use equipment maximum operating ambient, the PSU loading and input voltage, ventilation, end use equipment orientation, the position of doors & covers, etc. Temperatures should be monitored using type K fine wire thermocouples (secured with cyanoacrylate adhesive, or similar) placed on the hottest part of the component (out of any direct airflow) and the equipment should be run until all temperatures have stabilised.

COMPONENTS TO BE MONITORED

Circuit Ref. Description Max. Temperature (°C)

J1 Input connector 75* (105)

L1, L2 Common mode choke core 115, wire 140

C7, C8 X capacitors 100
C9 Reservoir capacitor (electrolytic) 70 (105)
L3 (EFE400) Boost choke core 115, winding 140
L3 (EFE400R) Boost choke/TRX core 115, winding 120
TX2 Transformer winding 120
TX2 Transformer core 120
TX2 Transformer braid (to pin 13) 120
U2 Optocoupler 75
C11 Channel 1 output capacitor 90 (105)
L7 Channel 1 Output choke 115
L4 Primary choke (24V model only) 120 (130)
XU8 Fan regulator 95
XQ225 Boost FET (IMS board) 115
Q1(EFE400) Channel 1 output FET 115
Q2(EFE400R) Channel 1 output FET 115
XU3 Main driver IC 100
Various All other electrolytic capacitors 90 (105)
See components to be monitored diagram in the handbook.
* For temperatures above 75°C a suitably temperature rated mating connector must be used.

Higher temperatures limits for electrolytic capacitors (in brackets) may be used but product life may be reduced.

Fans: The fan provided in this sub-assembly is provided with a fan guard to reduce the risk of operator contact with the rotor.

Technical Considerations

- The product was submitted and evaluated for use at the maximum ambient temperature (Tma) permitted by the manufacturer's specification of : 50°C Full load, increasing to 70°C maximum (output power derated 2.5% per degree above 50°C)
- The product is intended for use on the following power systems : TN
- Considered current rating of protective device as part of the building installation (A) : 20
- Mains supply tolerance (%) or absolute mains supply values : +10%/-10%
- The equipment disconnect device is considered to be : provided by the host installation
- The following are available from the Applicant upon request : Installation (Safety) Instructions / Manual
- PSU is linearly de-rated from 90Vac to 85Vac 5W per volt to 375W

Engineering Conditions of Acceptability

When installed in an end-product, consideration must be given to the following:

- The following product-line tests are conducted for this product : Earthing Continuity, Electric Strength
- The end-product Electric Strength Test is to be based upon a maximum working voltage of : Primary-Secondary: 402 Vrms, 768 Vpk, Primary-Earthed Dead Metal: 388 Vrms, 666 Vpk
- The following output circuits are at ES1 energy levels : 12V, 24V and Fan outputs
- The following output circuits are at ES2 energy levels : 48V output
- The following output circuits are at PS3 energy levels : All circuits
- The maximum investigated branch circuit rating is : 20 A
- The investigated Pollution Degree is : 2
- Proper bonding to the end-product main protective earthing termination is : Required
- An investigation of the protective bonding terminals has : been conducted

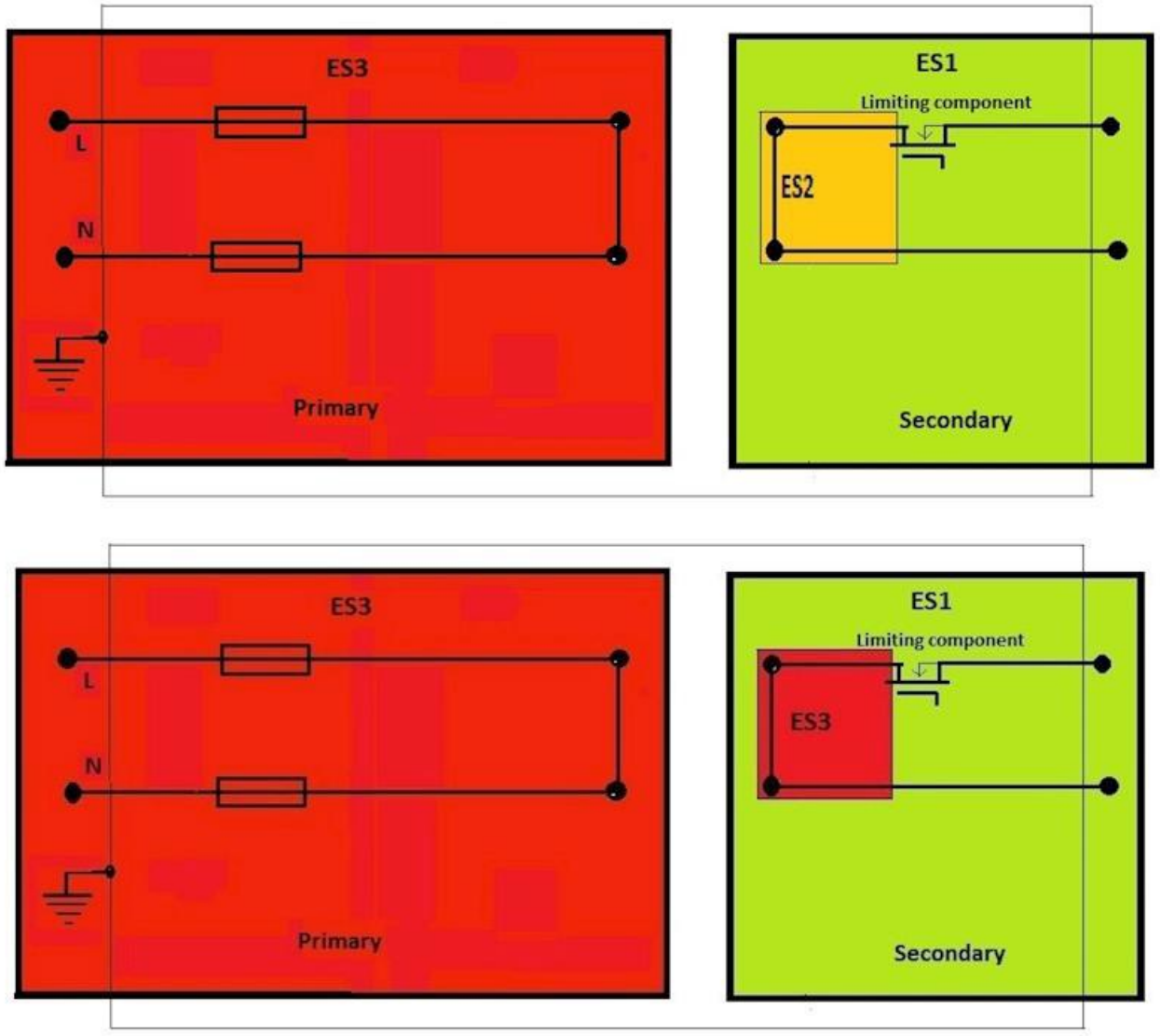
- The following end-product enclosures are required : Mechanical, Fire, Electrical
- The following magnetic devices (e.g. transformers or inductor) are provided with an OBJY2 insulation system with the indicated rating greater than Class A (105°C) : TX2, TX3, L3 and L5 (Class F) (155°C)
- The following components require special consideration during end-product Thermal (Heating) tests due to the indicated maximum temperature measurements during component-level testing : Models without a fan require component temperatures monitored as detailed in , Additional Information.
- The equipment is suitable for direct connection to : AC and/or DC mains supply
- The power supply was evaluated to be used at altitudes up to : 5,000 m
- When operated at a frequency greater than 60Hz, evaluation of the end equipment against the requirements of clause 5.7 must be considered.
- B.3.3 the test shall be considered in the end application.

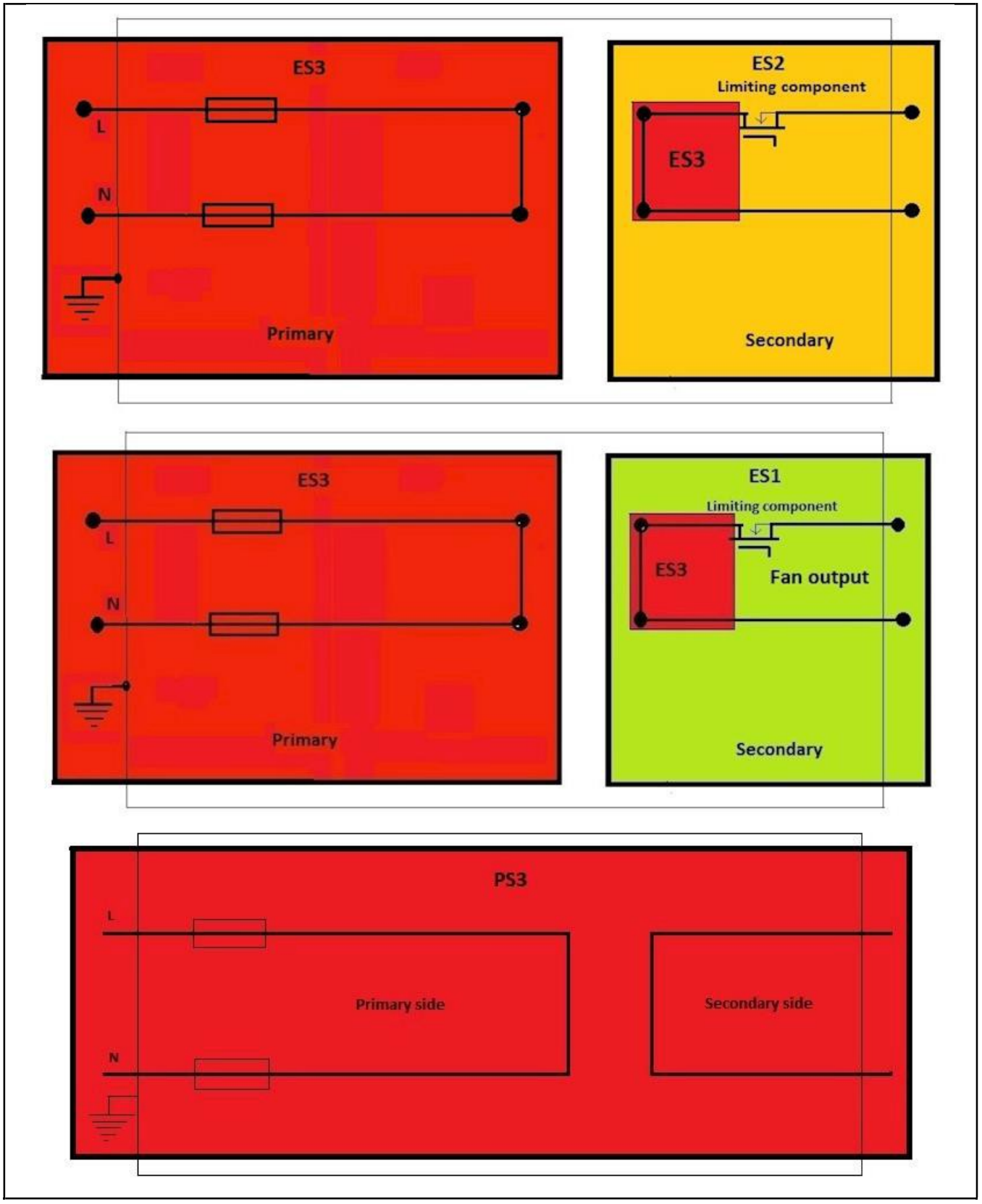
ENERGY SOURCE IDENTIFICATION AND CLASSIFICATION TABLE:	
(Note 1: Identify the following six (6) energy source forms based on the origin of the energy.) (Note 2: The identified classification e.g., ES2, TS1, should be with respect to its ability to cause pain or injury on the body or its ability to ignite a combustible material. Any energy source can be declared Class 3 as a worse case classification e.g. PS3, ES3.	
Electrically-caused injury (Clause 5): (Note: Identify type of source, list sub-assembly or circuit designation and corresponding energy source classification) Example: +5 V dc input ES1	
Source of electrical energy	**Corresponding classification (ES)**
Primary circuits (Not accessible)	ES3
Input connector (Stored capacitance) (Not accessible)	ES1
Secondary circuit before rectifier (TX2-D) 12V model (Not accessible)	ES2
Secondary circuit before rectifier (TX2-D) 24 and 48V models (Not accessible)	ES3
Secondary circuit before rectifier (TX2-C) 12, 24 and 48V models (Not accessible)	ES3
Secondary circuit after rectification (TX2-D) 12, 24V models	ES1
Secondary circuit after rectification (TX2-D) 48V model	ES2
Secondary circuit (Fan output) after rectification (TX2-C) 12, 24 and 48V models	ES1
Electrically-caused fire (Clause 6): (Note: List sub-assembly or circuit designation and corresponding energy source classification) Example: Batterypack (maximum 85 watts): PS2	
Source of power or PIS	**Corresponding classification (PS)**
All circuits	PS3 (Declared)
Injury caused by hazardous substances (Clause 7) (Note: Specify hazardous chemicals, whether produces ozone or other chemical construction not addressed as part of the component evaluation.) Example: Liquid in filled component Glycol	
Source of hazardous substances	**Corresponding chemical**
N/A	N/A
Mechanically-caused injury (Clause 8) (Note: List moving part(s), fan, special installations, etc. & corresponding MS classification based on Table 35.) Example: Wall mount unit MS2	
Source of kinetic/mechanical energy	**Corresponding classification (MS)**
Sharp edges/corners	MS1
Fan blades	MS1
Product mass	MS1

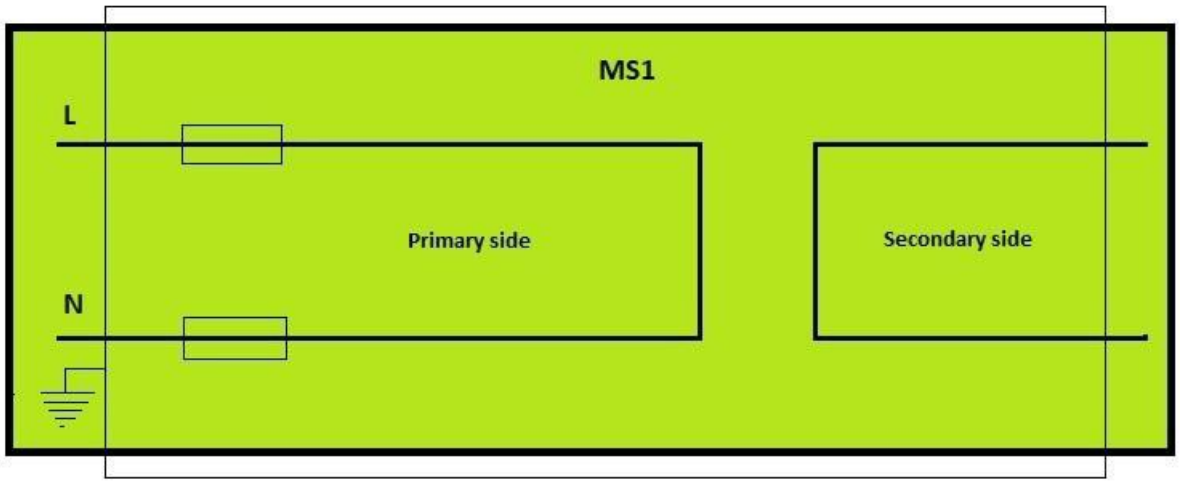
ENERGY SOURCE IDENTIFICATION AND CLASSIFICATION TABLE:	
Thermal burn injury (Clause 9) (Note: Identify the surface or support, and corresponding energy source classification based on type of part, location, operating temperature and contact time in Table 38.) Example: Hand-held scanner – thermoplastic enclosure TS1	
Source of thermal energy	**Corresponding classification (TS)**
Metal enclosure/chassis	TS3 (accessible to skilled person only)
Open frame power supply	TS3 (accessible to skilled person only)
Radiation (Clause 10) (Note: List the types of radiation present in the product and the corresponding energy source classification.) Example: DVD – Class 1 Laser Product RS1	
Type of radiation	**Corresponding classification (RS)**
N/A	N/A

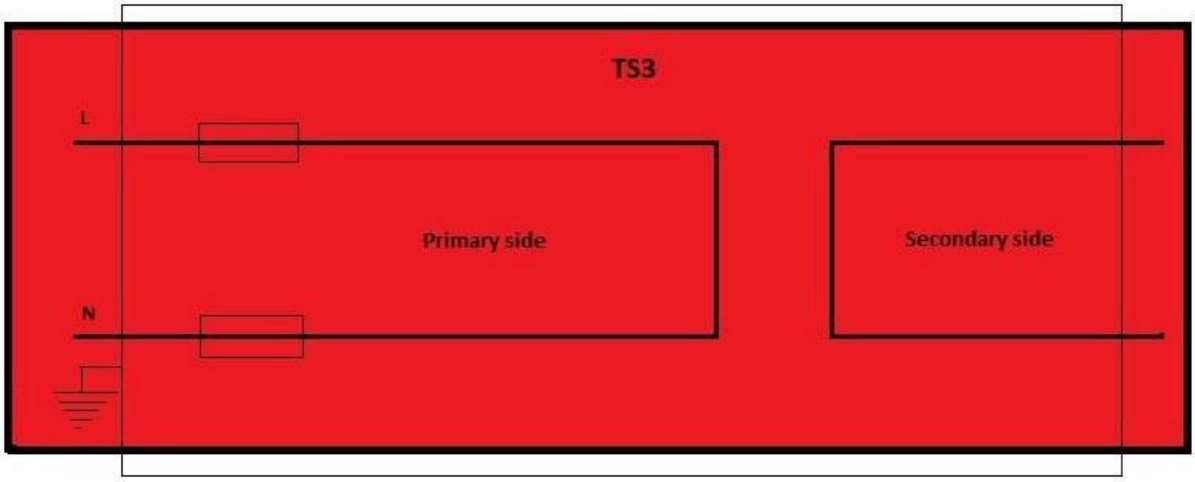
ENERGY SOURCE DIAGRAM
Indicate which energy sources are included in the energy source diagram. Insert diagram below

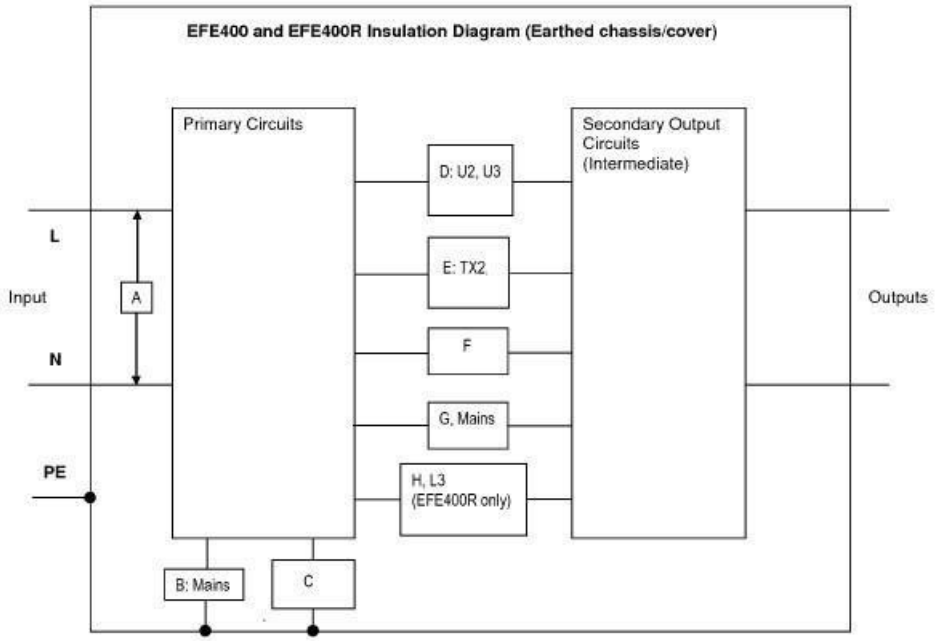
☒ ES ☒ PS ☒ MS ☒ TS ☐ RS




ES3
L
N
Primary
ES2
Limiting component
ES3
Secondary
ES3
L
N
Primary
ES1
Limiting component
ES3
Fan output
Secondary
PS3
L
N
Primary side
Secondary side


MS1
L
N
Primary side
Secondary side


TS3
L
N
Primary side
Secondary side


EFE400 and EFE400R Insulation Diagram (Earthed chassis/cover)
Primary Circuits
Secondary Output Circuits (Intermediate)
D: U2, U3
E: TX2
F
G, Mains
H, L3 (EFE400R only)
L
Input
N
PE
A
Outputs
B: Mains
C

OVERVIEW OF EMPLOYED SAFEGUARDS				
Clause	**Possible Hazard**			
5.1	Electrically-caused injury			
Body Part (e.g. Ordinary)	Energy Source (ES3: Primary Filter circuit)	Safeguards		
		Basic	Supplementary	Reinforced (Enclosure)
Ordinary person	ES3: Pins of input terminal (Not accessible to ordinary person, unit for building in)	Voltage is ES1 After 2 seconds	Voltage is ES1 after 2 seconds in a SFC	N/A
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	Y capacitors (See insulation diagram Area B & C)	Earthed chassis	N/A
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	Clearance & creepage (See insulation diagram Area B & C)	Earthed chassis	N/A
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	N/A	N/A	Clearance & Creepage (See insulation diagram Area E, F & G)
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	N/A	N/A	Opto-couplers (See insulation diagram Area D)
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	N/A	N/A	TX2, L3 (EFE400R) using TIW (See insulation diagram Area E & H)
Ordinary person (outputs maybe accessible)	ES3: Primary circuits	N/A	N/A	Distance Through Insulation (See insulation diagram area F) Transforme

				r cradle >0.4mm
6.1	Electrically-caused fire			
Material part (e.g. mouse enclosure)	Energy Source (PS2: 100 Watt circuit)	Safeguards		
		Basic	Supplementary	Reinforced
Transformers TX2, L3(EFE400R only)	PS3: Declared	No ignition occurred. Temperatures remained within limits during normal & abnormal conditions	Ignition reduced by complying with G.5.3	N/A
PWB	PS3: Declared	No ignition occurred. Temperatures remained within limits during normal & abnormal conditions	Control of fire spread achieved with PWBs made of V-1 minimum	N/A
All other components	PS3: Declared	No ignition occurred. Temperatures remained within limits during normal & abnormal conditions	Mounted on V-1 minimum rated PWB. CoA requires a fire enclosure be provided by the end equipment manufacturer.	N/A
7.1	Injury caused by hazardous substances			
Body Part (e.g., skilled)	Energy Source (hazardous material)	Safeguards		
		Basic	Supplementary	Reinforced
N/A	N/A	N/A	N/A	N/A
8.1	Mechanically-caused injury			
Body Part (e.g. Ordinary)	Energy Source (MS3:High Pressure Lamp)	Safeguards		
		Basic	Supplementary	Reinforced (Enclosure)
N/A	N/A	N/A	N/A	N/A
9.1	Thermal Burn			
Body Part (e.g., Ordinary)	Energy Source (TS2)	Safeguards		
		Basic	Supplementary	Reinforced
N/A	N/A	N/A	N/A	N/A

10.1	Radiation			
Body Part (e.g., Ordinary)	Energy Source (Output from audio port)	Safeguards		
		Basic	Supplementary	Reinforced
N/A	N/A	N/A	N/A	N/A
Supplementary Information:				
(1) See attached energy source diagram for additional details. (2) “N” – Normal Condition; “A” – Abnormal Condition; “S” Single Fault EFE400 & EFE400R are accessible to skilled persons only (Service Engineers). Output of power supply may be accessible to an Ordinary Person within the final unit providing it is ES1 (to be evaluated in the end application).				