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 ; Amendment 2 : 2024-03-18
Total number of pages .....:	97
Name of Testing Laboratory preparing the Report .....:	UL International Polska sp. z o.o.
Applicant's name.....:	**TDK-LAMBDA UK LTD**
Address .....:	**KINGSLEY AVE** **ILFRACOMBE** **EX34 8ES UNITED KINGDOM**
Test specification:	
Standard .....:	IEC 62368-1:2014
Test procedure .....:	CB Scheme
Non-standard test method.....:	N/A
TRF template used .....:	IECEE OD-2020-F1:2021, Ed.1.4
Test Report Form No.....:	IEC62368_1D
Test Report Form(s) Originator .....:	UL(US)
Master TRF.....:	Dated 2022-04-14

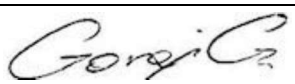
This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing CB Testing Laboratory.
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(s) .....:	TDK-Lambda
Manufacturer .....:	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM
Model/Type reference .....:	EFE400 or EFE-400 series 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). May be prefixed by SP followed by / or – (SP represents a sales code). Followed by x-a-bcde-f-g-hij. See test report model differences for details of models and nomenclature. EFE400R or EFE-400R series 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). May be prefixed by SP followed by / or – (SP represents a sales code). Followed by x-a-bcde-km-f-g-hij. See test report model differences for details of models and nomenclature.
Ratings .....:	100-240Vac, 45-440Hz, 6.1Arms Max, or, 133-318Vdc, 4.2Adc max

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	CB Testing Laboratory:		
Testing location/ address .....:		UL International Polska sp. z o.o. Równoległa 4, PL-02-235 Warszawa, Poland	
Tested by (name, function, signature) .....:		Kamil Janeczek / Project Handler	Janeczek Kamil
Approved by (name, function, signature).....:		Grzegorz Goraj / Reviewer	GorajG
☐	Testing procedure: CTF Stage 1:		
Testing location/ address.....:			
Tested by (name, function, signature) .....:			
Approved by (name, function, signature).....:			
☐	Testing procedure: CTF Stage 2:		

Testing location/ address..... :		
Tested by (name, function, signature) .....:		
Witnessed by (name, function, signature) ...:		
Approved by (name, function, signature).....:		
☒ Testing procedure: CTF Stage 3:		
☐ Testing procedure: CTF Stage 4:		
Testing location/ address.....:	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM	
Tested by (name, function, signature) .....:	Mark Gisbey / Tester	
Witnessed by (name, function, signature) ...:	Mark John De Sagun, Jan J. Jensen / Engineer	See GPI for Details
Approved by (name, function, signature).....:	Grzegorz Goraj / Reviewer	
Supervised by (name, function, signature)..:	Kamil Janeczek / Project handler	

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

National Differences (0 pages)
Enclosures (100 pages)

Summary of testing:

Tests performed (name of test and test clause):	**Testing Location:**
	Unless otherwise noted, test are all conducted in CTF Stage 3: TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM
5.4.1.8 – DETERMINATION OF WORKING VOLTAGE	
5.4.9.1 – ELECTRIC STRENGTH TEST – TYPE TESTING OF SOLID INSULATION	
5.7.4 – TOUCH CURRENT MEASUREMENT – EARTHED ACCESSIBLE CONDUCTIVE PARTS – SINGLE-PHASE EQUIPMENT ON IT SYSTEM	
B.2.6, 5.4.1.4, 6.3, 9.2, B.1.6 – NORMAL OPERATING CONDITIONS TEMPERATURE MEASUREMENT	
G.5.4.6.3 – ALTERNATIVE LOCKED-ROTOR OVERLOAD TEST FOR D.C. MOTOR	

Summary of compliance with National Differences:

List of countries addressed: Australia - AU, New Zealand - NZ, EU Group Differences, Japan - JP, United States of America - US, Canada - CA

☒ **The product fulfils the requirements of:** EN 62368-1:2014 + A11:2017, BS EN 62368-1:2014 + A11:2017, CSA CAN/CSA-C22.2 No. 62368-1 2nd Edition, Issued December 1, 2014

Use of uncertainty of measurement for decisions on conformity (decision rule) :

☒ No decision rule is specified by the IEC standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty ("simple acceptance" decision rule, previously known as "accuracy method").

☐ Other:… (to be specified, for example when required by the standard or client, or if national accreditation requirements apply)

Information on uncertainty of measurement:

The uncertainties of measurement are calculated by the laboratory based on application of criteria given by OD-5014 for test equipment and application of test methods, decision sheets and operational procedures of IECEE. IEC Guide 115 provides guidance on the application of measurement uncertainty principles and applying the decision rule when reporting test results within IECEE scheme, noting that the reporting of the measurement uncertainty for measurements is not necessary unless required by the test standard or customer.

Calculations leading to the reported values are on file with the NCB and testing laboratory that conducted the testing.

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 (°C)	70°C (de-rated output power by 2.5% per °C above 50°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.
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..... :	2022-09-21, 2023-08-08, 2023-02-09
Date (s) of performance of tests..... :	2022-11-30 to 2023-09-05, 2024-03-07
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 Trio-Tronics (Thailand) Ltd 7/295 Mu. 6 Map Yang Phon Sub-District Pluak Daeng District Rayong Province THAILAND

GENERAL PRODUCT INFORMATION:

Report Summary

The original report was modified on 2024-03-18 to include the following changes/additions:
Technical Amendment 2:

This report was modified to introduce the following changes:
- evaluation of units connected in series (connection of outputs)
- measurements of touch current at 440 Hz
- CCL table 4.1.2 revision due to correction of CB certificate for various components and addition of the following components: fan (optional) Yen Sun Technologies, model FD124020UB-H-NCB, FD124020UB-H-NAH and interchangeable generic description, Thermal pad for TX2 (cased version only): T-Global, Type L37-3 and Shiu Li Technology Co Ltd, AST45, C7, C8, C12, C13 X capacitors, Vishay Capacitors Belgium N V, model VY1 Series, C10 Y capacitor (optional), Murata mfg Co. Ltd., model RA series and Vishay Capacitors Belgium N V, model VY1 Series
- addition of a manufacturer Axis Corporation for L3 Boost choke/transformer - alternate (EFE400R only) and TX2 transformer
- update of L3 Boost Choke (change of bobbin from Sumikom PM-9820 to Sumikon PM-9630),
- addition of licenses marked as 8-01 to 8-09
- change of CBTL to UL International Polska Sp. z o.o.

The following tests were considered necessary:
5.4.1.8 – Determination of working voltage
5.4.9.1 – Electric strength test – type testing of solid insulation
B.2.6, 5.4.1.4, 6.3, 9.2 – Normal operating conditions temperature measurement
ANNEX G.5.4.6.3 – Alternative locked-rotor overload test for D.C. motors

Based on the previously conducted testing, additional testing and the review of product technical documentation, it has been determined that the product continues to comply with the standard.

This report should be read in conjunction with CBTR Ref. No. E135494-A6005-CB-1 Original, CBTC Ref. No. DK-81105-UL issued on 2019-02-27, CBTR Ref. No. E135494-A6005-CB-1 Amendment 1, CBTC Ref. No. DK-81105-M1-UL issued on 2022-06-21.

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).

May be prefixed by SP followed by / or – (SP represents a sales code)

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.

Series connection

It is possible to connect two units in series (EFE400 models only). Doing so changes the working voltages and also changes the Energy Source Classification. Refer to Conditions of Acceptability.

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 Instruction Manual/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 stabilized.

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 Instruction Manual.
* 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.

The following tests were selected as representative of the test program applicable to model covered by this CBTR: Capacitor discharge after disconnection of a connector (5.5.2.2), Determination of Working Voltage (Cl. 5.4.1.8), and Electric Strength Test - type testing of Solid Insulation (Cl. 5.4.9.1), Resistance of the protective bonding system (5.6.6), Touch current measurement – earthed accessible conductive parts – single-phase equipment on TN or TT system (5.7.5), Input test (B.2.5), Normal operating conditions temperature measurement (B.2.6), Simulated single fault conditions (B.4), Steady force test (T.5). These tests have been witnessed for models selected as representative of the standard covered by this report and the applicable test program. (Ref: 4790834540, 4790662104 and 4791153162, DA file 331).

Technical Amendment 2:

This report was modified to introduce the following changes:

- evaluation of units connected in series (connection of outputs)
- measurements of touch current at 440 Hz
- CCL table 4.1.2 revision due to correction of CB certificate for various components and addition of the following components: fan (optional) Yen Sun Technologies, model FD124020UB-H-NCB, FD124020UB-H-NAH and interchangeable generic description, Thermal pad for TX2 (cased version only): T-Global, Type L37-3 and Shiu Li Technology Co Ltd, AST45, C7, C8, C12, C13 X capacitors, Vishay Capacitors Belgium N V, model VY1 Series, C10 Y capacitor (optional), Murata mfg Co. Ltd., model RA series and Vishay Capacitors Belgium N V, model VY1 Series
- addition of a manufacturer Axis Corporation for L3 Boost choke/transformer - alternate (EFE400R only) and TX2 transformer
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The following tests were considered necessary:

5.4.1.8 – Determination of working voltage

5.4.9.1 – Electric strength test – type testing of solid insulation

B.2.6, 5.4.1.4, 6.3, 9.2 – Normal operating conditions temperature measurement

ANNEX G.5.4.6.3 – Alternative locked-rotor overload test for D.C. motors

Based on the previously conducted testing, additional testing and the review of product technical documentation, it has been determined that the product continues to comply with the standard.

This report should be read in conjunction with CBTR Ref. No. E135494-A6005-CB1-Original, CBTC Ref. No. DK-81105-UL issued on 2019-02-27, CBTR Ref. No. E135494-A6005-CB-1-Amendment 1, CBTC Ref. No. DK-81105-M1-UL issued on 2022-06-21.

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
- The product was investigated to the following additional standard : CSA CAN/CSA-C22.2 NO. 62368-1 2nd Ed, Issued December 1, 2014, EN 62368-1:2014 + A11:2017
- 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 ES3 energy levels : Series connected outputs
- 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 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
- The equipment was evaluated for end-product where reverse polarity is prevented. Otherwise B.3.3 the test shall be considered in the end application
- The following magnetic devices (e.g. transformers or inductor) are provided with an OBJY3 insulation system with the indicated rating greater than Class A (105°C) : TX2, TX3, L3 and L5 (Class F) (155°C)
- The maximum of 2 units of EFE400 models having output voltage 12 VDC or 24 VDC can be connected in series. This allowance is not applicable for EFE400R models having output voltage 48 VDC.
- Series connected outputs are classified as ES3. Accessibility shall be determined in end-product