






Test Report issued under the responsibility of:



<b>TEST REPORT</b> <b>IEC 62368-1</b> <b>Audio/video, information and communication technology equipment</b> <b>Part 1: Safety requirements</b>	
<b>Report Number</b> .....	E135494-A6054-CB-1
<b>Date of issue</b> .....	2022-05-06 ; Amendment 1 : 2022-08-01
<b>Total number of pages</b> .....	15
<b>Name of Test Laboratory</b> preparing the Report .....	UL VS Limited Unit 1-3 Horizon, Wade Road, Kingsland Business Park, Basingstoke RG24 8AH, United Kingdom
<b>Applicant's name</b> .....	<b>TDK-LAMBDA UK LTD</b>
<b>Address</b> .....	<b>KINGSLEY AVE</b> <b>ILFRACOMBE</b> <b>EX34 8ES UNITED KINGDOM</b>
<b>Test specification:</b>	
Standard .....	IEC 62368-1:2014
Test procedure .....	CB Scheme
Non-standard test method.....	N/A
<b>TRF template used</b> .....	IECEE OD-2020-F1:2020, Ed.1.3
<b>Test Report Form No</b> .....	IEC62368_1D
Test Report Form(s) Originator .....	UL(US)
Master TRF.....	Dated 2021-02-04
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Test Item description .....	Switch-mode Power Supply	
Trade Mark(s) .....	TDK-Lambda 	
Manufacturer .....	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM	
Model/Type reference .....	MU Series, limited to: zMU4FSDdef-ghi, zMU4FSEdef-ghi zMU4FSFdef-ghi, zMU4FSGdef-ghi  Where z, d, e, f, -ghi are alphanumeric characters specified in model differences section.	
Ratings .....	zMU4FSDdef-ghi, zMU4FSEdef-ghi Input: 100-240Vac nom, 8A rms max, 47-440Hz, Output: 600W 200-240Vac nom, 6A rms max, 47-440Hz, Output: 800W  zMU4FSFdef-ghi, zMU4FSGdef-ghi input: 144-318Vdc nom, 6A dc max, Output: 600W 278-318Vdc nom, 4.1A dc max, Output: 800W	
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input checked="" type="checkbox"/>	CB Testing Laboratory:	
Testing location/ address .....	UL VS Limited, Unit 1-3 Horizon, Wade Road, Kingsland Business Park, Basingstoke RG24 8AH, United Kingdom	
Tested by (name, function, signature).....:	Mark John De Sagun / Project Handler	
	Guoqing Zhang / Reviewer	
Testing procedure: CTF Stage 1:		
Testing location/ address .....		
Tested by (name, function, signature).....:		
Approved by (name, function, signature).....:		
Testing procedure: CTF Stage 2:		
<input type="checkbox"/>		

Testing location/ address.....:		
Tested by (name, function, signature).....:		
Witnessed by (name, function, signature) ...:		
Approved by (name, function, signature).....:		
<input checked="" type="checkbox"/>	Testing procedure: CTF Stage 3:	
<input type="checkbox"/>	Testing procedure: CTF Stage 4:	
Testing location/ address.....:	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM	
Tested by (name, function, signature).....:	N. Marsh, M. Carter, M. Gisbey / Tester	See the original CBTR for signatures
Witnessed by (name, function, signature) ...:	Mark John De Sagun / Witness Engineer	See the original CBTR for signatures
Approved by (name, function, signature).....:	Guoqing Zhang / Reviewer	See the original CBTR for signatures
Supervised by (name, function, signature) ..:	Mark John De Sagun / Project Handler	See the original CBTR for signatures

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

National Differences (0 pages)

Enclosures (0 pages)

**Summary of testing:****Tests performed (name of test and test clause):**  
None**Testing Location:** None**Summary of compliance with National Differences:****List of countries addressed:** EU Group and National Differences, Japan, USA / Canada **The product fulfils the requirements of:** BS EN 62368-1:2014 + A11:2017, EN 62368-1:2014 + A11:2017, CSA CAN/CSA-C22.2 No. 62368-1 2nd Edition, Issued December 1, 2014, AS/NZS 62368.1:2018**Statement concerning the uncertainty of the measurement systems used for the tests** **Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:****Procedure number, issue date and title:**

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

 **Statement not required by the standard used for type testing**

(Note: When IEC or ISO standard requires a statement concerning the uncertainty of the measurement systems used for tests, this should be reported above. The informative text in parenthesis should be delete in both cases after selecting the applicable option)

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

<b>TEST ITEM PARTICULARS:</b>	
Classification of use by	Skilled person
Supply Connection	AC Mains DC Mains
Supply % Tolerance	+10%/-10%
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)	45°C; 70°C (de-rated output power by 2.5% per °C above 50°C)
IP protection class	IPX0
Power Systems	TN TT dc mains
Altitude during operation (m)	5000 m
Altitude of test laboratory (m)	2000 m or less
Mass of equipment (kg)	1.1 (max)
<b>POSSIBLE TEST CASE VERDICTS:</b>	
- 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)
<b>TESTING:</b>	
Date of receipt of test item..... :	N/A
Date (s) of performance of tests..... :	N/A
<b>GENERAL REMARKS:</b>	
<p>"(See Enclosure #)" refers to additional information appended to the report.                      "(See appended table)" refers to a table appended to the report.</p> <p>Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.</p>	
<b>Manufacturer’s Declaration per sub-clause 4.2.5 of IEC62368_1D:</b>	

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 ..... :	<input checked="" type="checkbox"/> <b>Yes</b> <input type="checkbox"/> <b>Not applicable</b>
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**When differences exist; they shall be identified in the General product information section.**

<b>Name and address of factory (ies) .....</b> :	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
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**GENERAL PRODUCT INFORMATION:**

**Report Summary**  
 The original report was modified on 2022-08-01 to include the following changes/additions:  
 Amendment (Administrative): This report has been amended due to model description and nomenclature corrections.  
 This report should be read in conjunction with CBTR Ref. No: E135494-A6054-CB-1-Original, CBTC Ref. no: DK-127301-UL issued on 2022-05-09.

**Product Description**  
 The MU series of switch mode power supply consists of:  
 Main board:  
 1. Input filter, consisting of the input fuse(s), X and Y capacitors, common mode chokes up to the bridge.  
 2. PFC (boost circuit), consisting of the boost choke and associated switching FETs/circuitry.  
 3. Fan output  
 4. Forward converter switching circuitry  
 Module boards:  
 5. Main transformer.  
 6. Secondary circuits, consisting of Module output and signals.  
 Primary options:  
 7. Consisting of the transformer and switching IC/circuitry supplying the Primary Option output.  
 8. Secondary circuits, consisting of Primary Option output and signals.  
  
 (See Model Differences for details of nomenclature)

**Model Differences**  
 This report covers the MU series of switch mode power supplies. The MU series consists of a 4 slot model (MU4), with each slot capable of fitting a single module. The MU4 is available as 600W or 800W depending on the input voltage. Global option and PMBus Standby Options may be fitted.

MU modules nomenclature (Description):

zMUabcdef-ghi for modular configurations

Where:

z = Blank for standard product  
NS # followed by / or - (where # may be any number of characters indicating non-safety related model differences).  
SP followed by / or - (SP represents a sales code)

s = (Number of slots)  
4 for MU4 models

a = Cooling  
F for variable speed, forward air

b = (Input connection)  
S for screw

c = (Input fusing)  
D for dual AC fuse (L & N)  
E for single AC fuse in the live line  
F for dual AC/DC fuses  
G for single AC/DC fuse in the +ve input line

d = (Leakage current)  
L for 300uA  
R for 150uA

e = (Primary option)  
Blank for none fitted  
E5H for global enable with 5V standby  
T5H for global inhibit with 5V standby  
Q5xxxxx for 5V PMbus (where x may be any number or letter)

f = -CO for coating  
-COx for alternative coating (where x maybe any number)  
Blank for no coating

May be followed by non-safety related changes/ options:

-ghi

where:

ghi = Any 3 characters which may define non-safety related parameters/features,  
e.g reduced primary current limit, reduced OVP and coatings etc...



Blank for standard unit

Output modules nomenclature:

Single output modules

vMcd

where:

v = Output voltage, may be 5, 12, 24 or 48  
M = SB (Module name)  
c = S for screw (Output terminal)  
d = See letter from Module Signal Option Table

Blanking plates

B/S

where:

B/S = Blanking plate

Parallel output modules

vZxcd

where:

v = Output voltage, may be 5, 12, 24 or 48  
Z = Paralleled modules using SB modules  
x = Number of slots. Refer to Parallel and Series Combination Tables  
c = S for screw (Output terminal)  
d = See letter from Module Signal Option Table

Series output modules

vYxcd

where:

v = Output voltage, may be 5, 12, 24 or 48  
Y = Series modules using SB modules  
x = Number of slots. Refer to Parallel and Series Combination Tables  
c = S for screw (Output terminal)  
d = See letter from Module Signal Option Table

Series connected Paralleled modules

vHxcd

where:

v = Output voltage, may be 5, 12, 24 or 48  
H = Series connected parallel SB  
x = Number of slots. Refer to Parallel and Series Combination Tables  
c = S for screw (Output terminal)  
d = See letter from Module Signal Option Table

Units may be marked with a Product Code: KMUxy where x is the number of available slots and y may be any number of characters and K is a prefix that is used for a product code. This is an internal code only and is not part of the model nomenclature.

Module Signal Option Table

Table 1: x – module signal options (Remote sense built in to option)

Letter (x)	Module / output enable	Module / output inhibit	Module / output good (inc LED)	Share bus for paralleling	Remote Sense
L	Option not fitted				
B	No	No	No	No	Yes
C	Yes	No	No	No	Yes
D	No	Yes	No	No	Yes
F	Yes	No	Yes	No	Yes
G	No	Yes	Yes	No	Yes
H	Yes	No	Yes	Yes	Yes
J	No	Yes	Yes	Yes	Yes

Parallel and Series Combination Tables

Series connection number of slots.

Qty of modules	Using series SB modules	Slots
1	SB	1
2	YC	2

Limitations of use:

1. Output voltage is the combined series modules voltage.
2. Module limitations apply to series modules.

Parallel connection number of slots

Slots	Number of parallel SB modules	Module name
2	2	ZC
3	3	ZT

See ratings in Module output ratings table below

Series connection of parallel connected modules

Module	Qty	Slots	Module name
ZC	2	4	HC

Input parameters

MU4

Input voltage nom. 100 - 240Vac, 144 - 318Vdc (200 - 240Vac, 239 - 318Vdc)\*

Input voltage range 85 - 264Vac, 130 - 350Vdc (180 - 264Vac, 215 - 350Vdc)\*

Input frequency range 47 - 440Hz or dc

Maximum input current 8A rms or 6A dc (6A rms or 4.1A dc)\*

\* Input details for 800W models.

Maximum ambient 70°C, total output power and module output power de-rated by 2.5% per °C above 50°C

Output parameters

Module	Note	Slots	Channel	Vout (nom)	Range (V)	Output Current (A) Max	Output power (W) Max
SB	-	1	1	5	3.3-6	30	150
SB	-	1	1	12	6-15	20	240
SB	-	1	1	24	15-30	10	240
SB	-	1	1	48	30-52	5	240

Series modules

Refer to the table below for series module Energy Source Classification and SELV classification.

Only two modules may be fitted in series

Any module type not shown in table below must be considered as Non-SELV and ES3

Module Code	Slots	Number of Outputs	Module Description	ES1/ SELV (Module nominal voltage used)	ES2 (Module nominal voltage used) Non-SELV	ES3 NON-SELV
SB	1	1	Single Module	3.3-6V 6-15V 15-30V 30-52V	30-52V	-
YC	2	1	Modules connected in series	6.6-12V 12-30V	30-60V	60-104V

If the total voltage of outputs connected in series exceeds the ES1 limit then all outputs must be considered ES2 or ES3 as appropriate.

Outputs that are either ES2 or ES3 are hazardous and must not be made user accessible. Consideration must be given to service engineers making inadvertent contact with the output terminals in the end equipment.

Cooling options MU4

Cooling Option	Input voltage	Output Power (W)	Ambient(°C)	Derating
F (Forward air, variable speed)	100-240Vac, 144-318Vdc	600	45	50°C is achievable with input voltages above 111Vac input or 160Vdc input. Ambient is de-rated from 50°C down to 45°C, linearly, with input voltages from 111Vac down to 100Vac, or 160Vdc down to 144Vdc. Module and output power derated by 2.5% per °C above 50°C, up to 70°C max.
F (Forward air, variable speed)	200-240Vac, 239-318Vdc	800	50	Module and output power derated by 2.5% per °C above 50°C, up to 70°C max.

Additional information

- 600W and 800W AC input PSU Models are identical in hardware, the only difference is the input rating, so that the end application use will determine input rating to be used depending on the output required
- 600W and 800W DC input PSU Models are identical in hardware, the only difference is input rating, so that the end application use will determine input rating to be used depending on the output required

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

The marking label provided is representative of all models.

The following tests were selected as representative of the test program applicable to model covered by this CBTR: Normal Operating Conditions Temperature Measurement (Cl. B.2.6), Simulated Abnormal Operating Conditions (Cl. B.3), Electric Strength Test (Cl. 5.4.9).

These tests have been witnessed for models selected as representative of the standard covered by this report and the applicable test program.

The power rating marked on label relates to output power.

Cooling for units used in an ambient between 45 and 50°C.

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 the standard in question. 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.

Cooling for unit temperature table (see layout drawings below):

Circuit Ref.	Description	Max. Temperature (°C)
PFC	--	--
MU4	--	--
J1	Input connector	(105)
F1	Fuse support	(125)
L204	Common Mode Choke	125 (155)
L206	Series mode choke	125 (140)
L207, L208	Boost choke	125 (145)
C1, C2, C3, C4	Electrolytic Capacitors	85 (105)
C102	Electrolytic Capacitors	74 (105)
C207, C208	X Capacitor	(100)
C211, C214, C225, C226	Y Capacitor	(125)
ASY205	Diode bridge	125 (130)
XU6	IC	(85)
Global Options/ PMbus	--	--
XU161	Opto-couplers	(100)
XU3	Opto-couplers	100 (125)
TX1	Transformer Class F	(130)
SB module Modules	--	--
C101, C102, XC100	Electrolytic Capacitors	88 (105)
C104, C105	Y Capacitor	(125)
XU1	Opto-couplers	100 (125)
TX1	Transformer Class F	(130)
L101	Output Choke	110 (140)

Higher temperature limits (in brackets) may be used but product life may be reduced.

### Technical Considerations

- The product was submitted and evaluated for use at the maximum ambient temperature (T<sub>ma</sub>) permitted by the manufacturer's specification of : 45°C; , 70°C (de-rated output power by 2.5% per °C above 50°C). See model differences for details.
- The product is intended for use on the following power systems : TN, TT, DC mains supply
- Considered current rating of protective device as part of the building installation (A) : 20
- Mains supply tolerance (%) or absolute mains supply values : +10%/-10% (test at extended tolerance up to 85Vac is for reference only).
- The equipment disconnect device is considered to be : provided in the end product
- The following were investigated as part of the protective earthing/bonding : Printed wiring board trace (refer to Enclosure - Schematics + PWB for layouts)
- The following are available from the Applicant upon request : Installation (Safety) Instructions / Manual
- The product was investigated to the following additional standard : EN 62368-1:2014 + A11:2017, CSA CAN/CSA-C22.2 NO. 62368-1 2nd Ed, Issued December 1, 2014
- (for reference only) Multilayer PWB's accepted under CBTR Ref. No E349607-A23 dated 2020-09-18 and Letter Report included in Enclosure 7-06 & 7-07 of this report.
- The minimum CLEARANCE is multiplied by 1.48 to correspond with an altitude of 5000m as per IEC60664-1.
- For the models with dual fuse, an instructional safeguard shall be provided in the end product.

**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 – Earthed Dead Metal: 406 Vrms/558 Vpk, Primary-Secondary: 468 Vrms/541 Vpk
  - The following output circuits are at ES1 energy levels : SB and YC modules (see Model differences or ES table)
  - The following output circuits are at ES2 energy levels : SB and YC modules (see Model differences or ES table)
  - The following output circuits are at ES3 energy levels : YC module (see Model differences or ES table)
  - 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
  - An investigation of the protective bonding terminals has : been conducted
  - The following end-product enclosures are required : Electrical, Fire, Mechanical
  - 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) : TX1, SB modules and Global options Class F (155°C). See Critical Components Table for details of insulation systems used.
  - The following components require special consideration during end-product Thermal (Heating) tests due to the indicated maximum temperature measurements during component-level testing : Refer to additional information for details (special consideration during end product evaluation for ambients between 45 and 50°C).
  - The power supply was evaluated to be used at altitudes up to : "5,000 m"
  - The power supply terminals and/or connectors are: Not investigated for field wiring. To be considered in end-application.
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- The fan provided in this sub-assembly is not intended for operator access
  - The following output terminals were referenced to earth during performance testing: All outputs and their return lines individually referenced to earth to obtain maximum working voltages
  - For protection from moving parts, the required mechanical enclosure must prevent access to the fan blades. Fan blades should only be accessible to a skilled person after the removal of the metal enclosure. The moving part is obvious
  - TS3 metal chassis/enclosure accessible to skilled person, skilled safeguard to be considered in the end-product.
  - Code 2, factory and field wiring.
    - The suitability of the connections (including spacings between factory connectors) and field wiring shall be determined in the end-use application.
  - Where the specified Tma is 45°C, an elevated Tma (for example 50°C) can be considered and evaluated in the end use application allowing for specific load and input conditions.