Test Report issued under the responsibility of:

TEST REPORT

IEC 60950-1
Information technology equipment – Safety – Part 1: General requirements

Report Number. .....:	E135494-A6053-CB-1
Date of issue .....:	2022-05-09 ; Amendment 1 : 2022-08-01
Total number of pages.....	15
Name of Testing Laboratory preparing the Report .....:	UL VS Limited Unit 1-3 Horizon, Wade Road, Kingsland Business Park, Basingstoke RG24 8AH, United Kingdom
Applicant's name .....:	TDK-LAMBDA UK LTD
Address .....:	KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM
Test specification:	
Standard.....:	IEC 60950-1:2005, AMD1:2009, AMD2:2013
Test procedure .....:	CB Scheme
Non-standard test method .....:	N/A
Test Report Form No. .....:	IEC60950_1G
Test Report Form(s) Originator ....:	SGS Fimko Ltd
Master TRF.....:	Dated 2019-07-02

If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

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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Test item description ..... :	Switch-mode Power Supply
Trade Mark ..... :	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):

☒	**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	
Approved by (name, function, signature)...:		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:**		

Testing location/ address.....:			
Tested by (name + 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).....:		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):	**Testing Location:**
	CTF Stage 3: TDK-LAMBDA UK LTD **KINGSLEY AVE** **ILFRACOMBE** **EX34 8ES UNITED KINGDOM**
Guide Information Page - Maximum Output Voltage, Current, and Volt Ampere Measurement (1.2.2.1)	
Input: Single-Phase (1.6.2)	
Energy Hazard Measurements (2.1.1.5, 2.1.2, 1.2.8.10)	
Capacitance Discharge (2.1.1.7)	
SELV Reliability Test Including Hazardous Voltage Measurements (2.2.2, 2.2.3, 2.2.4, Part 22 6.1)	
Limited Short-Circuit (2.6.3.4)	
Protective Bonding I (2.6.3.4, 2.6.1)	
Humidity (2.9.1, 2.9.2, 5.2.2)	
Determination of Working Voltage; Working Voltage Measurement (2.10.2)	
Thin Sheet Material (2.10.5.9, 2.10.5.10, 2.10.5.6)	
Steady Force (4.2.1 - 4.2.4)	
Heating (4.5.1, 1.4.12, 1.4.13)	
Ball Pressure (4.5.5, 4.5)	
Touch Current (Single-Phase; TN/TT System) (5.1, Annex D)	
Electric Strength (5.2.2)	
Component Failure (5.3.1, 5.3.4, 5.3.7)	
Abnormal Operation (5.3.1 - 5.3.9)	
Transformer Abnormal Operation (5.3.3, 5.3.7b, Annex C.1)	
Power Supply Output Short-Circuit/Overload (5.3.7)	
Locked-Rotor Overload and Endurance (Annex B.5, B.8)	

Summary of compliance with National Differences:

List of countries addressed: Argentina, China, EU Group and National Differences, Israel, Japan, Korea, Singapore, USA, Canada

☒ **The product fulfils the requirements of:** EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013, CSA CAN/CSA-C22.2 No. 60950-22-17, Issued March 31, 2017, AS/NZS 60950.1:2015

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

Test item particulars..... :	
Equipment mobility	for building-in
Connection to the mains	mating connector
Operating condition	continuous
Access location	for building-in
Over voltage category (OVC)	OVC II
Mains supply tolerance (%) or absolute mains supply values	+10%, -10%
Tested for IT power systems	No
IT testing, phase-phase voltage (V)	N/A
Class of equipment	Class I (earthed)
Considered current rating of protective device as part of the building installation (A)	20
Pollution degree (PD)	PD 2
IP protection class	IP X0
Altitude of operation (m)	5000
Altitude of test laboratory (m)	less than 2000 meters
Mass of equipment (kg)	1.1 (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.....:	N/A
Date (s) of performance of tests .....:	N/A

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

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-A6053-CB-1-Original, CBTC Ref. no: DK-127302-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):

zMUsabcdef-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	ES2 (Module nominal	ES3 NON-SELV

				nominal voltage used)	voltage used) 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 (SELV) limit then all outputs must be considered ES2 or ES3 (Non-SELV) as appropriate.

Outputs that are either ES2 or ES3 (non-SELV) 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: Heating test (Cl. 4.5.1, 1.4.12, 1.4.13), Abnormal Operation Tests (Cl. 5.3.1 - 5.3.9), Electric Strength Test (Cl. 5.2.2).

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 (Tma) 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 means of connection to the mains supply is : to be determined in the end-equipment.
- The product is intended for use on the following power systems : TN, TT, DC mains supply
- The equipment disconnect device is considered to be : provided in the end product
- The product was investigated to the following additional standards : EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013 (which includes all European national differences, including those specified in this test report).
- 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
- Mains supply tolerance (%) or absolute mains supply values : +10%/-10% (test at extended tolerance up to 85Vac is for reference only).
- (for reference only) Multilayer PWB's accepted under CBTR Ref. No E349607-A23 dated 2020-09-18 and Letter Report included in Enclosure 7-05, 7-06 of this report.
- The minimum CLEARANCE is multiplied by 1.48 to correspond with an altitude of 5000m as per IEC 60664-1.
-
- 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 Production-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: 408 Vrms/541 Vpk
- The following secondary output circuits are SELV : All except 48V SB module and specific series modules. Refer to Model Differences for series modules which may not be SELV.
- The following secondary output circuits are at hazardous energy levels : All modules except those listed as non-hazardous
- The following secondary output circuits are at non-hazardous energy levels : 5V SB module, 5V primary options.
- The power supply terminals and/or connectors are : Not investigated for field wiring. To be considered in end-application.
- 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 : Not been conducted
- 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 end-product enclosures are required : Electrical, Fire
- 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).
- Fans : 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
- EMC compliance has not been verified nor has it been taken into consideration. An accredited EMC Test Report will be required in conjunction with the Certification of the end product
- The product was evaluated for use at the maximum altitude of operation: 5000 m.
- The power supply terminals and/or connectors are: Not investigated for field wiring. To be considered in end-application.

- 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.

Abbreviations used in the report:

- normal conditions	**N.C.**	- single fault conditions	**S.F.C**
- functional insulation	**OP**	- basic insulation	**BI**
- double insulation	**DI**	- supplementary insulation	**SI**
- between parts of opposite polarity	**BOP**	- reinforced insulation	**RI**

Indicate used abbreviations (if any)