UL TEST REPORT AND PROCEDURE

Standard:	UL 62368-1, 2nd Ed, 2014-12-01 (Audio/video, information and communication technology equipment Part 1: Safety requirements) CAN/CSA C22.2 No. 62368-1-14, 2nd Ed, Issued: 2014-12-01 (Audio/video, information and communication technology equipment Part 1: Safety requirements)
Certification Type:	Component Recognition
CCN:	QQJQ2, QQJQ8 (Power Supplies for Use in Audio/Video, Information and Communication Technology Equipment)
Complementary CCN:	N/A
Product:	Switch-mode Power Supply
Model:	MU series (followed by alphanumeric characters – see model differences section in Test Report for details of models and nomenclature)
Rating:	MU4 (600W): 100-240Vac nom, 47-440Hz, 8A rms max MU4 (800W): 200-240Vac nom, 47-440Hz, 6A rms max MU4 (600W): 144-318Vdc nom, 6A dc max MU4 (800W): 278-318Vdc nom, 4.1A dc max
Applicant Name and Address:	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE EX34 8ES UNITED KINGDOM

This is to certify that representative samples of the products covered by this Test Report have been investigated in accordance with the above referenced Standards. The products have been found to comply with the requirements covering the category and the products are judged to be eligible for Follow-Up Service under the indicated Test Procedure. The manufacturer is authorized to use the UL Mark on such products which comply with this Test Report and any other applicable requirements of UL LLC ('UL') in accordance with the Follow-Up Service Agreement. Only those products which properly bear the UL Mark are considered as being covered by UL's Follow-Up Service under the indicated Test Procedure.

The applicant is authorized to reproduce the referenced Test Report provided it is reproduced in its entirety.

UL authorizes the applicant to reproduce the latest pages of the referenced Test Report consisting of the first page of the Specific Technical Criteria through to the end of the Conditions of Acceptability.

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL.

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Reviewed By: Guoqing Zhang / Reviewer

Supporting Documentation

The following documents located at the beginning of this Procedure supplement the requirements of this Test Report:

A. Authorization - The Authorization page may include additional Factory Identification Code markings.

B. Generic Inspection Instructions -

i. Part AC details important information which may be applicable to products covered by this Procedure. Products described in this Test Report must comply with any applicable items listed unless otherwise stated in the body of this Test Report.

ii. Part AE details any requirements which may be applicable to all products covered by this Procedure. Products described in this Test Report must comply with any applicable items listed unless otherwise stated in the body of each Test Report.

iii. Part AF details the requirements for the UL Certification Mark which is not controlled by the technical standard used to investigate these products. Products are permitted to bear only the Certification Mark(s) corresponding to the countries for which it is certified, as indicated in each Test Report.

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 single modules. The MU4 is available as 600W or 800W depending on the input voltage. High power/Low power and PMBus Standby Options may be fitted.

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.

Unit configuration Code (Description):

May be prefixed with NS # followed by / or - (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)

Nomenclature (applicable to MU models)

Nomenclature

MUsabcdef-ghi for modular configurations
Where:

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:

Single output modules
vMcd
where:

v = Output voltage
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
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
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
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

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

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) Non-SELV	ES2 (Module nominal voltage used)	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.

Test Item Particulars	
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)

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 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

For use only in or with complete equipment where the acceptability of the combination is determined by UL LLC. 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.

- 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.

Additional Information

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.

Additional Standards

The product fulfills 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

Markings and Instructions

Clause Title	Marking or Instruction Details
Equipment identification marking – Manufacturer identification	Listee’s or Recognized companys name, Trade Name, Trademark or File Number
Equipment identification marking – model identification	Model Number

Equipment rating marking – ratings	"Input Ratings (voltage, frequency/dc, current/power)", "Output Ratings (voltage, frequency/dc, current/power)"
Special Instructions to UL Representative N/A	