

UL TEST REPORT AND PROCEDURE

Standard:	UL 62368-1, 3rd Ed, 2021-10-22 (Audio/video, information and communication technology equipment Part 1: Safety requirements) CAN/CSA C22.2 No. 62368-1:19, 3rd Ed, 2021-10-22 (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:	AC-DC Power Supply
Model:	EFE400M or EFE-400M series (see Model Differences for details of models and nomenclature)
Rating:	100-240Vac nom, 45-440Hz, 6.1A rms max. or 133-318Vdc nom, 5A max. (See Model Differences for details of ratings)
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.

Prepared By: Maggie Chiu / Project Handler Reviewed By: David Snook / 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 EFE400M or EFE-400M series are switch-mode power supplies for building into host equipment.

Model Differences

EFE400M or EFE-400M models as described below:

Units may be marked with a Product Code: U6x or Y6x where x may be any number of characters.

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

Unit Configuration Code (Description :) may be prefixed by SP followed by / or - (SP represents a sales code)

Unit Configuration Code:

EFE400Mxy-a-b-cdef-gh-i-j-klm

where:

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

y = Blank for Y2 capacitors from output to earth

P for Y1 capacitors from output to earth

D for Class II (with Y1 capacitors)

a = Channel 1 output Voltage (see Ch1 in the table below, adjustment range column).

b = Standby voltage: see standby voltage in table below.

c = BC for cover and U chassis without fan grill, with fan fitted (temperature controlled). (Y60001x model only)

HN for Open frame, no fan, with 12V / 1A fan supply.

HU for U chassis (not EFE400MxD models), no fan, with 12V / 1A fan supply.
HC for Cover + chassis (not EFE400MxD models), no fan, with 12V / 1A fan supply.
EC for Cover + chassis (not EFE400MxD models), end fan (temp controlled).
NN for Open frame, no fan, no fan supply.
NU for U chassis (not EFE400MxD models), no fan, no fan supply.
NC for Cover + chassis (not EFE400MxD models), no fan, no fan supply.
HP for perforated cover, no fan, with 12V / 1A fan supply.
NP for perforated cover, no fan, no fan supply.
TF for Cover + chassis (not EFE400MxD models), Top Fan (fixed speed)

d = M for Molex KK type 41791 input connector or equivalent.

S for Molex Sabre type 43160 input connector or equivalent.

e = D for AC input with dual fusing.

F for AC/DC input with dual fusing.

E for single fuse input in the Live line.

G for single fuse input in the + line

f = L for low Leakage.

R for reduced Leakage.

T for tiny Leakage.

Z for EFE400MxD models (Class II).

where $L < 300\mu\text{A}$ leakage, $R < 150\mu\text{A}$ leakage and $T < 75\mu\text{A}$ leakage.

g = Y for Oring FET included.

N for no Oring FET.

h = T for inhibit.

E for enable.

N for no remote signals

i = V for vertical output connector or nothing for horizontal output connector.

j = 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, 18PD = 1.8V of positive load regulation).

klm = 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)

Input Parameters

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Nominal input voltage 100-240Vac 133-318Vdc

Input voltage range 90-264Vac 120-350Vdc

Input frequency range 45-440Hz dc

Maximum input current 6.1Arms 5A

*Input de-rated, see variations and limitations below.

All ratings apply for ambient temperatures up to 50°C. (see variations and limitations below)

Output Parameters

There are three EFE400M standard models and two non-standard models with various options and output parameters shown in the tables below.

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**)
	48	47 - 50*	8.33	400 (470**)
Fan output (optional)	12	12	1	12
Standby output	5	5	2	10
	12	12 - 12.2*	1	12.2

Variations and limitations of use for Standard models:

1. Output power de-rated 1% per volt from 100V to 90V input (channel 1 power 360W at 90V input).
2. Output power further de-rated 2% per volt from 90V to 85V input (channel 1 power 320W at 85V input).
3. Maximum ambient 70°C (de-rating output power 2.5% per °C above 50°C).
4. * Can be adjusted at the factory only.
5. Maximum continuous power output 400W (including fan output).
6. ** Peak power for 10 seconds maximum, maximum rms power of 400Wrms:

Non-Standard Models:

Non- Standard model: Y60001# (# can be any letter) (EFE400M-48-5-BCSDL-NT)

Output Channel	Vout Nom.	Adjustment Range (V)	Output Current (A)	Maximum Power (W)
Channel 1	48	47 to 50*	8.33	400
Standby output	5	fixed	2	10

Variations and limitations of use for Non- Standard model Y60001#:

1. Output power de-rated 1% per volt from 100V to 90V input. (e.g. channel 1 power 360W at 90V input)
2. Maximum ambient 50°C.
3. * Can be adjusted at the factory only.

Non- Standard model: Y60002# (# can be any letter) (EFE400M-12-5-NNMDL-NE-V)

Output Channel	Vout Nom.	Adjustment Range (V)	Output Current (A)	Maximum Power (W)
Channel 1	12	11.4 - 13.2*	47.5	450 (530**)
Standby output	5	fixed	2	10

Variations and limitations of use for Non- Standard model Y60002#:

1. Output power de-rated linearly from 450W to 410W from 100V to 90V input. (e.g. channel 1 power 410W at 90V input)
2. IEC/EN60950-1 only.
3. Maximum ambient 40°C.
4. * Can be adjusted at the factory only.
5. ** Peak power for 10 seconds maximum, maximum rms power of 400W.

Test Item Particulars

Product group	built-in component
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	20 A; Location: building
Equipment mobility	for building-in
Over voltage category (OVC)	OVC II
Class of equipment	Class I Class II (for model with suffix 'y' = 'D')
Special installation location	N/A
Pollution degree (PD)	PD 2
Manufacturer's specified Tma (°C)	50°C (Full Load); 70°C (Output power decreased linearly by 2.5%/°C above 50°C)
IP protection class	IPX0
Power systems	TN TT
Altitude during operation (m)	5000 m or less m
Altitude of test laboratory (m)	2000 m or less
Mass of equipment (kg)	1Kg Max

Technical Considerations

- The product was submitted and evaluated for use at the maximum ambient temperature (T_{ma}) permitted by the manufacturer's specification of : 50°C (full load); 70°C (output power decreased linearly by 2.5%/°C above 50°C).
- 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 : +10%/-10% for both AC mains and DC mains supply
- The equipment disconnect device is considered to be : provided by the end equipment
- 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
- Further evaluation must be considered in the end use product if used in IT power systems. Capacitors are rated for 230V due to the IT power system used in Norway.
- Equipment was evaluated for a maximum supply range of 85-264Vac and 120-350Vdc.
- Components have been evaluated for compliance to IEC or national standards. It shall be noted that provision of clause 4.1.1 was considered for components and subassemblies complying with IEC 60950-1 or IEC 60065 used as part of equipment covered by this standard without further evaluation other than to give consideration to the appropriate use of the component or subassembly in the end-product. Additional certificates may be required at the discretion of the accepting NCB or local authorities.

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 output circuits are at ES1 energy levels : 12 and 24V (Nom) outputs after rectification of TX2
- The following output circuits are at ES2 energy levels : 48V (Nom) output after rectification of TX2
- The following output circuits are at PS3 energy levels : All circuits
- When installed in an end-product, consideration must be given to the following:
 - H4 is connected to the input connector Earth and this must be considered for Class I open frame models in the end equipment.
 - The following Production-Line tests are conducted for this product: Electric Strength, Earthing Continuity
 - The end-product Electric Strength Test is to be based upon a maximum working voltage of:
Primary-Secondary: 396 Vrms, 922 Vpk. , Primary-Earthed Dead Metal: 381 Vrms, 672 Vpk
 - Series connection of channel 1 is permitted however a maximum limit of 2 units must not be exceeded.
 - Series operation is not permitted for DC Input or Class II variants.
 - 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 voltage.
 - The power supply terminals and/or connectors are: Not investigated for field wiring
 - 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 (except EFE400MxD Class II models)
 - 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): Transformer TX1 and TX2 - Class F
 - The following end-product enclosures are required: Fire, , Electrical and Mechanical,
 - An investigation of the protective bonding terminals has: Been conducted
- When operated at frequencies in excess of 63Hz, the requirements for Touch Current and Protective Conductor Current must be considered in the end equipment. as the leakage current for input frequencies above 63Hz may exceed 5mA.

- Ratings in the end product need to be evaluated due to the use of input voltage dependent de-rating.
- The perforated cover when fitted to the EFE400MxD models (Class II) must be treated as a live part with Basic Insulation from primary to chassis and Supplementary Insulation from secondary circuit to chassis.
- Products are restricted to connection to DC Mains conditioned power supply system with narrower tolerance +10%, -10%.
- Marking for equipment provided with fuses located in both line and neutral of a single phase mains to be considered in end-product

Additional Information

Only ELECTRIC STRENGTH TEST was conducted under this report. All the other required tests were carried out under the original investigation evaluated per IEC/UL 62368-1:2014 (2nd edition) in CBTR Ref. No: E135494-A6009-CB-1-Original, including Amendment-1, Correction-1, Amendment-2 and Amendment-3; CBTC Ref. no: DK-92032-M3-UL issued on 2022-08-24. The test sample received dates and the test dates are from the original report. Per the previously conducted testing and the review of product technical documentation including photos, schematics, wiring diagrams and similar, it has been determined that the product continues to comply with the standard. Refer to Section "Test performed" covering all conducted performance tests in those reports.

The following tests were selected as representative of the test program applicable to model covered by this CBTR: Normal Operating Conditions Temperature Measurement, Simulated Abnormal Operation Conditions

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

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

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

Circuit Ref.	Description	Max. Temperature (°C) †
J1	input connector	105 (75††)
C12, C8, C7	X cap	100
L1, L2	Common mode choke winding	130 (145)
L6	Series mode choke winding	130
TX1	Standby trx winding	130
U2, U3, U5, U6, U7	Opto-coupler	100
TX2	Primary, secondary windings and core	130
C5	Capacitor	85 (105)
C9	Boost capacitor	70 (105)
L3	Boost choke winding	130 (140)
L7	Channel 1 output choke	130
XQ225	Boost FET (ASY2 primary IMS)	125 (130)
Q2	Chan1 O/P FET (ASY4 secondary IMS)	125 (130)
L8	Prim resonant choke (not 12V model)	130 (140)
J2	Output connector	105
XL701 1A	fan output choke	110 (125)
C1, C11, C19, C20	Electrolytic capacitors	75 (105)

† The higher temperatures limits in brackets may be used but product life may be reduced.


Single sided or double sided boards refer to Daughter and IMS boards while Multi-layer boards refer to Main board.

Additional Standards

The product fulfills the requirements of: BS EN IEC 62368-1:2020 + A11:2020, EN IEC 62368-1:2020+A11:2020, CAN/CSA C22.2 No. 62368-1:19, 3rd Edition, Revised October 22, 2021, UL 62368-1 3rd Edition, Revised October 22, 2021

Markings and Instructions

Clause Title	Marking or Instruction Details
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See Installation Instructions	The symbol 
Equipment identification marking – Manufacturer identification	Listee's or Recognized Company's 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)"
Fuses – replaceable by skilled person	(component ID: _____), Ratings (____ A), "Ratings (____ A, ____ V)", and (symbol of required characteristics) located on or adjacent to fuse or fuseholder or in service manual.
<p>Special Instructions to UL Representative</p> <p>The clearance between Asy 2 (IMS) to Chassis side top shall be verified and this shall be no less than 3.0mm. See enclosure 4-05 for the factory work instruction and enclosure 7-09</p>	