

UL TEST REPORT AND PROCEDURE

Standard:	UL 60950-1, 2nd Edition, 2014-10-14 (Information Technology Equipment - Safety - Part 1: General Requirements) CAN/CSA C22.2 No. 60950-1-07, 2nd Edition, 2014-10 (Information Technology Equipment - Safety - Part 1: General Requirements)
Certification Type:	Component Recognition
CCN:	QQGQ2, QQQQ8 (Power Supplies for Information Technology Equipment Including Electrical Business Equipment)
Product:	Switch mode 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 100-240Vac nom, 45-440Hz, 6.1A rms max. 133-318Vdc nom, 5A max. (See Model Differences for details of ratings)
Applicant Name and Address:	TDK-LAMBDA UK LTD KINGSLEY AVE ILFRACOMBE DEVON 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.

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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

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:

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.

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NP for perforated cover, no fan, no fan supply.

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 < 300uA leakage, R < 150uA leakage and T < 75uA leakage.

g = Y for Oring FET included.
N for no Oring FET.

h = T for inhibit.
E for enable.

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

Standard	60601-1	60950-1	60950-1
Nominal input voltage	100 - 240 Vac	100 - 240 Vac	133 - 318 Vdc
Input voltage range	90 - 264Vac*	90 - 264Vac*	120 - 350Vdc
Input frequency range	45 - 63Hz	45 - 440Hz	DC
Maximum input current	6.1A rms	6.1A rms	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**)

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	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.

Technical Considerations

- Equipment mobility : for building-in
- Connection to the mains : To be determined in the end application
- Operating condition : continuous
- Access location : for building-in
- Over voltage category (OVC) : OVC II
- Mains supply tolerance (%) or absolute mains supply values : +10%, -10%

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- Tested for IT power systems : Yes (Norway only)
- IT testing, phase-phase voltage (V) : 230V
- Class of equipment : Class I (earthed) and Class II models (double insulated)
- Considered current rating of protective device as part of the building installation (A) : 20A
- Pollution degree (PD) : PD 2
- IP protection class : IP X0
- Altitude of operation (m) : 5,000m
- Altitude of test laboratory (m) : 64m
- Mass of equipment (kg) : 1kg max.
- The product was submitted and evaluated for use at the maximum ambient temperature (T_{ma}) permitted by the manufacturer's specification of: 70°C (output de-rated 2.5% per °C above 50°C)
- The product is intended for use on the following power systems: TN, TT
- 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
- The product was investigated to the following additional standards: CSA C22.2 No. 60950-1-07 + A1:2014, EN 60950-1:2006 + A1:2010 + A11:2009 + A12:2011 + A2:2013, UL 60950-1 2nd Ed. Revised 2014-10-14
- Multilayer PWB's accepted under CBTR Ref. No. E349607-A23 dated 2014-07-31 and letter report Enclosure 8-05 of this report.

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:

- 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-SELV: 396 Vrms, 922 Vpk. , Primary-Earthed Dead Metal: 381 Vrms, 672 Vpk
- The following secondary output circuits are SELV: All
- The following secondary output circuits are at hazardous energy levels: Channel 1
- The following secondary output circuits are at non-hazardous energy levels: Standby supply, fan output
- 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
- 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 the "Additional Information" section.
- Fans: The fans provided in these power supplies do not present a danger.
- Limited Current Circuits Clause 2.4 for EFE400MxD models requires assessment in the end equipment.
- Touch Current and Protective Conductor Current Clause 5.1 for the EFE400MxD models requires assessment in the end equipment.
- The perforated cover when fitted to the EFE400MxD models (Class II) must be treated as a live part with Basic/Supplementary insulation to primary and Basic/Supplementary insulation to secondary.

Additional Information

This report is a reissue of CBTR Ref. No. E135494-A67-CB-2 dated 2012-11-26 and E135494-A67-CB-2 amendment 1 dated 2014-01-16, CB Test Certificate Ref. No. DK-29375-A1-UL dated 2014-01-16, due to upgrade to IEC 60950-1 2nd Edition + Amd 2.

Based on previously conducted testing and the review of product construction, only limited testing of model EFE400M was considered necessary for the following revisions:

1. Enclosures updated.
2. Adding/removing alternates, making corrections and updating component Certificates in the Critical Components list.
3. Adding alternate Y.S. Tech FD124020UB-H-NAH fan. (Thermal test)
4. Assessed for Class II, EFE400MxD models with increased Y1 capacitor values to 4n7. (leakage test, limitation added to Condition of Acceptability, working voltage)
5. Nomenclature change to allow a single input fuse in the live/+ line
6. Increased X capacitor C7 from 330n to 470n max, XR54 and XR55 discharge resistors reduced to 270kohm max. (discharge test)
7. F2 fault test. (fault test for F2 none Safety critical component)
8. Increased Y capacitors C21 and C22 from 3n3 to 4n7. (leakage test)
9. Addition/deletion of multilayer PWBs to critical component list.
10. Perforated Cover option added. (Creepage and Clearance assessment, Electric Strength)
11. Factory name change from Trio Engineering Co Ltd to Panyu Trio Microtronic Co., Ltd,
12. Delete rating "94.5-240Vac nom"

Cooling for units with customer supplied air (all models except -BC and -EC)

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) †
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	Channel 1 output FET (ASY4 secondary IMS)	125 (130)
L8	Primary 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.

Additional Standards

The product fulfills the requirements of: CSA C22.2 No. 60950-1-07 + A1+ A2 :2014, EN 60950-1:2006 + A1:2010 + A11:2009 + A12:2011 + A2:2013, UL 60950-1 2nd Ed. Revised 2014-10-14