

## UL TEST REPORT AND PROCEDURE

<b>Standard:</b>	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)
<b>Certification Type:</b>	Component Recognition
<b>CCN:</b>	QQGQ2, QQGQ8 (Power Supplies for Information Technology Equipment Including Electrical Business Equipment)
<b>Product:</b>	Switched Mode Power Supply
<b>Model:</b>	EFE400 or EFE-400, EFE400R or EFE-400R series. (may be followed by characters as described in Model Differences, see Model Differences for details)
<b>Rating:</b>	100-240 Vac nom or 133-318 Vdc nom, 45-440 Hz 6.1 Arms max, 4.2 A DC max (see Model Differences for details)
<b>Applicant Name and Address:</b>	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.

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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### 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 EFE400 or EFE-400 and EFE400R or EFE-400R Series are switch mode power supplies for building into host equipment.

### Model Differences

EFE400 or EFE-400 models as described below:

Units may be marked with a Product Code: U4x or Y4x where x may be any number of characters.

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

Unit Configuration Code:

EFE400x-a-bcde-f-g-hij

Where:

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

a = Channel 1 Output Voltage: any voltage within the Adjustment Range for the Vout (nom) from the Output Table below, e.g. 12.8 for 12.8V output (12Vout nom), 24.6 for 24.6V output (24Vout nom).

b = CN for Open Frame with fan output, CU for U chassis with fan output, CC for U chassis and cover with fan output, EC for U chassis and cover with fan (temperature controlled).

c = M for molex input connector or equivalent, J for JST connector or equivalent.

d = D for dual fused input, FL for single fuse input in the Live Line.

e = S for Standard Leakage, L for Low Leakage, R for Reduced Leakage, T for Tiny Leakage.\*

f = Nothing for horizontal output connector, V for vertical output connector.

g = 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, 24PD = 2.4V of positive load regulation).

hij = 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).

Output Parameters

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**)
Fan output (optional)	12	Fixed	0.25	3

Variations and limitations of use:

1. Maximum ambient 70°C (de-rating output power 2.5% per °C above 50°C).
2. \* Can be adjusted at the factory only.
3. Maximum continuous power output 400W (excluding fan output).
4. \*\* Peak power for 10 seconds maximum, maximum rms power of 400Wrms.

EFE400R or EFE-400R models as described below:

Units may be marked with a Product Code: U4x or Y4x where x may be any number of characters.

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

Unit Configuration Code:

EFE400Rx-a-bcde-km-f-g-hij

Where:

- x = Nothing or J for Japanese models (may have non-safety differences)
- a = Channel 1 Output Voltage: any voltage within the Adjustment Range for the Vout (nom) from the Output Table below.
- b = CN for Open Frame with fan output, CU for U chassis with fan output, CC for U chassis and cover with fan output, EC for U chassis and cover with fan (temperature controlled), NN for open frame with no fan output.
- c = M for molex input connector or equivalent, J for JST connector or equivalent.
- d = D for dual fused input, FL for single fuse input in the Live Line.
- e = S for Standard Leakage, L for Low Leakage, R for Reduced Leakage, T for Tiny Leakage.\*
- f = Nothing for horizontal output connector, V for vertical output connector.
- g = 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, 24PD = 2.4V of positive load regulation).
- hij = 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).
- k = Y for or-ing device or N for none fitted.
- m = E for enable or T for inhibit.

Output Channel	Vout Nom.	Adjustment Range (V)	Max Output Current (A)	Maximum Power (W)
Channel 1	48	47-50*	8.5	400 (470**)
Fan output (optional)	12	Fixed	0.25	3

Variations and limitations of use:

1. Maximum ambient 70°C (de-rating output power 2.5% per °C above 50°C).
2. \* Can be adjusted at the factory only.
3. Maximum continuous power output 400W (excluding fan output).
4. \*\* Peak power for 10 seconds maximum, maximum rms power of 400Wrms.

#### Technical Considerations

- Equipment mobility : for building-in
- Connection to the mains : not directly connected to the mains
- Operating condition : continuous
- Access location : for building-in
- Over voltage category (OVC) : OVC II
- Mains supply tolerance (%) or absolute mains supply values : DC units: 120-350V; AC units: 90-264V
- Tested for IT power systems : Yes
- IT testing, phase-phase voltage (V) : 230V (Norway only)
- Class of equipment : Class I (earthed)
- 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) : 3000m
- Altitude of test laboratory (m) : 64m
- Mass of equipment (kg) : 1kg max
- Equipment acceptable for operation up to 3000 Metres
- The product is intended for use on the following power systems: TN
- The equipment disconnect device is considered to be: provided by the host installation
- The following are available from the Applicant upon request: Installation (Safety) Instructions / Manual
- The product was submitted and evaluated for use at the maximum ambient temperature (T<sub>ma</sub>) permitted by the manufacturer's specification of: 50°C Full load, increasing to 70°C maximum (output power derated 2.5% per degree above 50°C)
- 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).

#### 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:

- When operated at a frequency greater than 63Hz, evaluation of the end equipment against the requirements of clause 5.1.7 must be considered.
- PSU is linearly de-rated from 90Vac to 85Vac 5W per volt to 375W
- 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 Additional Information.

- The end-product Electric Strength Test is to be based upon a maximum working voltage of: Primary-SELV: 402 Vrms, 768 Vpk Primary-Earthed Dead Metal: 388 Vrms, 666 Vpk
- The following secondary output circuits are SELV: All
- The following secondary output circuits are at hazardous energy levels: Channel 1 only
- The following secondary output circuits are at non-hazardous energy levels: Fan output
- The power supply terminals and/or connectors are: Suitable for factory wiring only
- 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: Been conducted
- 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): TX2, TX3, L3 and L5 (Class F) (155°C)
- The following end-product enclosures are required: Mechanical, Fire, Electrical
- Fans: The fan provided in this sub-assembly is provided with a fan guard to reduce the risk of operator contact with the rotor.

#### Additional Information

Factory Production Note: Model EFE400 Series is produced at all three Factories noted on the CB Certificate. Model EFE400R Series is produced in the UK and China Factories noted on the CB Certificate but is not produced in the Factory located in Japan.

Cooling for units with customer supplied air (all except EC models):

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 IEC60950-1. 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.

#### COMPONENTS TO BE MONITORED

Circuit Ref.	Description	Max. Temperature (°C)
J1	Input connector	75* (105)
L1, L2	Common mode choke	core 115, wire 140
C7, C8	X capacitors	100
C9	Reservoir capacitor (electrolytic)	70 (105)
L3 (EFE400)	Boost choke	core 115, winding 140
L3 (EFE400R)	Boost choke/TRX	core 115, winding 120
TX2	Transformer winding	120
TX2	Transformer core	120
TX2	Transformer braid (to pin 13)	120

U2	Optocoupler	75
C11	Channel 1 output capacitor	90 (105)
L7	Channel 1 Output choke	115
L4	Primary choke (24V model only)	120 (130)
XU8	Fan regulator	95
XQ225	Boost FET (IMS board)	115
Q1(EFE400)	Channel 1 output FET	115
Q2(EFE400R)	Channel 1 output FET	115
XU3	Main driver IC	100
Various	All other electrolytic capacitors	90 (105)

See components to be monitored diagram in the handbook.

\* For temperatures above 75°C a suitably temperature rated mating connector must be used.

Higher temperatures limits for electrolytic capacitors (in brackets) may be used but product life may be reduced.

This report is a reissue of CBTR Ref. No. E135494-A31-CB-3, CB Test Certificate Ref. No. DK-29308-UL, to upgrade to IEC 60950-1 2nd Edition + Amd 2. Based on previously conducted testing and the review of product construction, only 4.5.1 - Heating Test and Annex B7 - Locked-rotor overload tests were deemed necessary to cover the following additional changes:

1. Addition/deletion of multilayer PWBs to critical component list
2. Correction/addition to critical component list
3. Enclosures updated to include revised handbook, drawings, certificates and marking plate
4. Alternative fan added (Y.S. Tech)
5. Cemented joint test result updated

Based on 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.

#### Additional Standards

The product fulfills the requirements of: EN 60950-1:2006 + A1:2010 + A11:2009 + A12:2011 + A2:2013