

## UL TEST REPORT AND PROCEDURE

<b>Standard:</b>	UL 61010-1, 3rd Edition, 2012-05-11 (ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE - Part 1: General Requirements) CAN/CSA-C22.2 No. 61010-1, 3rd Edition, 2012-05, (ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE - Part 1: General Requirements)
<b>Certification Type:</b>	Component Recognition
<b>CCN:</b>	QQHC2, QQHC8 (Power Supplies for Measurement, Control and Laboratory Use)
<b>Product:</b>	Switch 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, 45-440 Hz 6.1 Arms 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.

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<p><b>Supporting Documentation</b></p> <p>The following documents located at the beginning of this Procedure supplement the requirements of this Test Report:</p> <p>A. Authorization - The Authorization page may include additional Factory Identification Code markings.</p> <p>B. Generic Inspection Instructions -</p> <ul style="list-style-type: none"><li>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.</li><li>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.</li><li>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.</li></ul>
<p><b>Product Description</b></p> <p>The EFE400 or EFE-400 and EFE400R or EFE-400R Series are switch mode power supplies for building into host equipment.</p>
<p><b>Model Differences</b></p> <p>EFE400 or EFE-400 models as described below:</p> <p>Units may be marked with a Product Code: U4x or Y4x where x may be any number of characters.</p> <p>Unit Configuration Code (Description :) may be prefixed by NS # (where # may be any number of characters indicating non-safety related model differences).</p> <p>Unit Configuration Code:</p> <p>EFE400x-a-bcde-f-g-hij</p> <p>Where:</p> <p>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).</p> <p>Output Parameters</p>

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**

- Type of item tested : Laboratory
- Description of equipment function : switch mode power supply
- Connections to mains supply : via host equipment
- Overvoltage category : II
- Pollution degree : 2
- Means of Protection : Class I (PE connected)
- Environmental conditions : Normal
- For use in wet locations : No
- Equipment mobility : N/A, for building into host equipment
- Operating conditions : continuous
- Overall size of the equipment: (W X D X H) (mm) : 85 x 198 x 41 with end fan and cover
- Mass of the equipment (kg) : less than 1kg
- Marked degree of protection to IEC 60529 : none
- Equipment classification: Professional, Commercial
- Equipment class: Class I
- Equipment type: For building-in
- The product was submitted and tested for use at the maximum recommended ambient temperature (Tmra) of: 50°C (70°C de-rated above 50°C, see Model Differences)
- Evaluated for a maximum altitude of 3000m

**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:

- This component has been judged on the basis of the creepage and clearances required in the indicated Standards, which would cover the component itself if submitted for Listing: UL 61010-1 3rd Ed., CAN/CSA 22.2 No. 61010-1-12 3rd Ed., IEC/EN61010-1:2010, 3rd Ed.
- The end-product shall consider that: The enclosure does not serve as a fire/electrical/mechanical enclosure
- The need for the following shall be considered in the end-product: Bonding to protective earthing terminal (Class I construction), MAINS disconnected device
- The output connectors are: Not investigated for field wiring
- Creepage and clearance distances were based on a maximum working voltage of: 349 Vrms; 666 Vpeak Basic, 286 Vrms; 768 Vpeak Reinforced
- Insulation between primary circuits and accessible dead metal complies with the requirements for : Basic insulation

- Insulation between primary and secondary circuits complies with the requirements for: Reinforced insulation
- The following tests shall be performed in the end-product evaluation: Dielectric Strength (in accordance with the handbook), Temperature (for customer air models, see Additional Information)
- The unit is considered acceptable for use at on a max branch circuit of: 20 A
- The unit is considered acceptable for use in a max ambient of: 70°C (de-rated above 50°C, see Model Differences for details)
- End-product temperature tests for power supplies shall consider that the following transformers employ the indicated insulation system: Transformer TX2, Class F (155 °C)
- End-product dielectric strength tests shall be based on the maximum working voltage of: 349 Vrms; 666 Vpeak primary to earth, 286 Vrms; 768 Vpeak primary to secondary
- At input frequencies above 63Hz Clause 6.4.4a requires investigation in the end application
- Customer air models must be thermally tested as described in the Additional Information
- Input connector J2 pin 1 has been investigated as the protective bonding terminal for the product
- The risk associated with clause 5.4.5 requires assessment in the end equipment
- Input connector is: Not investigated for field wiring

**Additional Information**

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.

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 IEC61010-1. 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 re-issue of CBTR Ref. No. E331788-A19-CB-1, CB Test Certificate Ref. No. DK-34008-UL dated 2013-07-26. Based on previously conducted testing and the review of product construction, only the cooling test 4.4.2.10 and temperature test 10.1-10.4 were deemed necessary to cover the following 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. Change of factory name + address and CBTL

#### Additional Standards

The product fulfills the requirements of: UL 61010-1 3rd Ed., CAN/CSA 22.2 No. 61010-1-12 3rd Ed., EN61010-1:2010