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, QQGQ8 (Power Supplies for Information Technology Equipment Including Electrical Business Equipment)
Complementary CCN:	QQHM2, QQHM8 (Power Supplies, Medical and Dental)
Product:	Power Supply
Model:	NV700 or NV-700 Range, RA-PFC-001 (see Model Differences for details of NV700 Range model configurations)
Rating:	NV700 or NV-700 Range: 100-240Vac nominal (90-264V max. tolerance), 47-440Hz, 11A (see Model Differences for details of model ratings) RA-PFC-001: input: 100-240Vac nominal (90-264V max. tolerance), 47-63Hz, 11A max. output: 350Vdc, 2.3A max.
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.

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: Mike Burns - 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

NV700 or NV-700 series or power supplies for building into end equipment. (see Model Differences for details of model configurations) and RA-PFC-001 (the RA-PFC-001 is comprised of only a filter/boost assembly, chassis, cover, fan assembly, output assembly and output terminal block)

Model Differences

RA-PFC-001 consists of the main PFC Converter without any NV700 modules fitted.

NV700 models as described below:

Units may be marked with a Product Code: K7x or NV7x where x may be up to any six letters and/or numbers 0 to 9.

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

Unit Configuration (Description :) Code:

a) NV-700x or NV7x (these models are identical)

where x = H for high hold-up or blank for standard hold-up

b) followed by: S, C or U

where	S	=	Forward airflow, standard fan
	C	=	Customer air, fan not fitted
	U	=	Customer air, fan not fitted, cover not fitted

c) followed by: S or I

where	S	=	Screw input terminals
	I	=	IEC input

d) followed by: S, M, L, R, or T

where	S	=	Standard Leakage (Class B Filter)
	M	=	Medium Leakage

	L	=	Low Leakage
	R	=	Reduced Leakage
	T	=	Tiny Leakage

Unit configuration may be given using the above code and/or by the option description. The input terminal type (screw or IEC) may alternatively be determined by examination of the unit.

e) optionally followed by: EN#V, EN*V, IN#V, IN*V, ES#V, ES*V, IS#V, IS*V.

where	EN#V	=	AC good, global module good, PSU enable, 5-5.5V, 2A standby output
	EN*V	=	AC good, global module good, PSU enable, 12-13.5V, 1A standby output
	IN#V	=	AC good, global module good, PSU inhibit, 5-5.5V, 2A standby output
	IN*V	=	AC good, global module good, PSU inhibit, 12-13.5V, 1A standby output
	ES#V	=	AC good, PSU enable, 5-5.5V, 2A standby output
	ES*V	=	AC good, PSU enable, 12-13.5V, 1A standby output
	IS#V	=	AC good, PSU inhibit, 5-5.5V, 2A standby output
	IS*V	=	AC good, PSU inhibit, 12-13.5V, 1A standby output

where # represents the standby output voltage and is in the range 5 to 5.5V
where * represents the standby output voltage and is in the range 12-13.5V

The Global Options Inhibit and Enable functions permit the customer to turn off or on the main psu outputs and the fan. The standby supply is for use by the customer and provides an SELV output that continues to operate when all the main psu outputs have been turned off using the Inhibit or Enable functions. All the functions of the Global Option pass through a single 8 way PWB socket and are all rated SELV.

Modules:

Up to 4 of the following modules types may be fitted:

@B

or @C

or @CM

or @BH

where @ is the output voltage of the module and is within the range given in the single output module table.

or @/#DB or @_#DB

where @ is the output voltage of channel 1 and # is the output voltage of channel 2 of the module. Voltages are within the range given in the DB module tables.

or @/#DA or @_#DA

where @ is the output voltage of channel 1 and # is the output voltage of channel 2 of the module. Voltages are within the range given in the DA module tables. Only 1 DA module may be fitted.

or B/S or B_S

where B/S indicates that a blanking plate is fitted in place of a module.

The following nomenclature may optionally be used for outputs connected in series:
(Note that outputs may be connected in series even when this nomenclature is not used)

@BB or @ BHB or @BBH or @BHBH or @CC or @CCM

where @ is the total voltage of any two B, BH, C or CM modules connected in series.

or @/#BDB or @_#BDB or @BHDB

where @ is the total series voltage of any B or BH module and DB module channel 1. # is the output voltage of the DB module channel 2. Voltages for # are within the range given in the DB module tables.

or @HDB

where @ is the total series voltage of any DB module channel 1 and channel 2.

For all outputs connected in series:
Permissible min. value for @ is given by summing the min. voltage ratings of the outputs connected in series.
Permissible max. value for @ is given by summing the max. voltage ratings of the outputs connected in series.

Custom Models:

Model: NV-700 RSS IN5V 12BH 12BH
Maximum outputs: 12.5V, 20A; 12.5V, 20A (total power 500W max.)
Maximum ambient: 65°C with 2.5%/°C derating of total power and module current above 50°C
Orientations: Horizontal with chassis lowest, on either side or vertical with the airflow upwards.
Comments: PSU has reverse air.

Model: NV-700 CSS ES5V 12C (NV722DCC and NV7Y019T)
Maximum output: 12V, 37.5A (peak power rating as given in electrical and thermal ratings section on following page)
Maximum ambient: 65°C with 2.5%/°C derating of total power and module current above 50°C
Orientations: Horizontal with chassis lowest, on either side or vertical with the airflow upwards.

Output Interface Assembly:

One of the following output interface assemblies may optionally be fitted:

Wxxx

where xxx is a number between 001 and 999. These assemblies attach to the module output(s) and contain circuitry providing one or more of the following: current sharing, reduced current limit, fusing, sequencing, diode or-ing, module good, filtering, connectors or terminal blocks for outputs or signalling purposes, indicator lamps or LEDs.

Documentation to be made available to the customer detailing ratings of all assembly outputs.

ELECTRICAL AND THERMAL RATINGS

Nominal Input Voltage	100 - 240 Vac
Input Voltage Range	90 - 264 Vac #
Input Frequency Range	47 - 440 Hz
Maximum Input Current	11 A rms

Subject to limitations, see table below.

Code	Cooling Option	Input Voltage) Range (Vac)	Total output power (W)	Maximum ambient (°C)	Derating
S	Forward airflow standard fan	90 - 99.9	700W continuous (850W peak if 700W average #)	65	2.5% per °C above 45°C
S	Forward airflow standard fan	100 - 149.9	700W continuous (850W peak if 700W average #)	65	2.5% per °C above 50°C
S	Forward airflow standard fan	150 - 264	1150W continuous (1450W peak if 1150W average #)	65	2.5% per °C above 45°C
C, U	Customer air fan not fitted	Refer to Customer Air Cooling section for details			

Global Option standby outputs (12-13.5V at 1A or 5-5.5V at 2A) should not be included when calculating total PSU output power.
The total output power, module output currents and Global Option output currents are derated by the given value.
The PSU may output the given peak power for up to 10 seconds providing that the average power from the PSU does not exceed the stated value.

Global Options with output voltages between 5.01 and 5.5V have their max. output current linearly derated from 2A at 50°C ambient to 1.4A at 65°C ambient.

Permitted orientations: Horizontal with chassis lowest, on either side or vertical with the airflow upwards.

Single Output Modules:

Module	Nominal Voltage (V)	Voltage Range (V) #	Max. Current
B	3.3	3.135 - 3.6	40A
	5	4.75 - 5.5	4.75 - 5.0V: 40A 5.0 - 5.5V: Linearly derate from 40 to 36A
	8	7 - 9	7 - 8V: 22.5A 8 - 9V: Linearly derate from 22.5 to 20A
	12	12 - 15.5	12 - 12.5V: 19.5A 12.5 - 15.5V: Linearly derate from 19.5 to 15A
	24	24 - 28	24V: 10A 24 - 28V: Linearly derate from 10 to 8A
BH	12	12 - 15.5	12 - 12.5V: 20A

			12.5 - 15.5V: Linearly derate from 20 to 15.5A
	24	24 - 28	24V: 10A
			24 - 28V: Linearly derate from 10 to 8.5A
C & CM	12	12 - 13.2	12V: 37.5A. Derated to 450W above 12V
	16	15 - 17.6	15 - 16V: 28.12A. Derated to 450W above 16V
	24	24 - 26.4	24V: 18.75A. Derated to 450W above 24V
	30	27 - 32	27V: 16.67A. Derated to 450W above 27V

C & CM modules may output up to 600W for up to 10 seconds providing that the average power from the module does not exceed 450W.

Dual Output Modules:

Dual Output Modules, Output 1

Module	Nominal Voltage (V)	Voltage Range (V) #	Max. Current
DA	12	12.25	3A
DB	3.3	3.135 - 3.6	25A
	5	4.75 - 5.5	25A
	6	5.5 - 6.5	25A
	12	12 - 15.5	12 - 12.5V: 13A
			12.5 - 15.5V: Linearly derate from 13 to 10A
	24	24 - 28	24 - 25V: 7A
			25 - 28V: Linearly derate from 7 to 6A

Dual Output Modules, Output 2

Module	Nominal Voltage (V)	Voltage Range (V) #	Max. Current(A)	Max. Power(W)
DA	12	(-)11.6 - (-)11.9	1	11.9
DB	5	3.3 - 6	10	60
	12	7 - 15.5	5	60
	24	24 - 32	2	50

Voltage measured at the module power terminals. This voltage must not be exceeded when remote sense is used.
DB modules with 6V nominal channel 1 derated as follows:
Ch.1 : 5.5 - 6V Ch.1 + Ch.2 : 195W total.
Ch.1 : 6.01 - 6.5V Ch.1 + Ch.2 : 170W total.

The DB module may be used with output 1 up to 24V at 8.3A and output 2 up to 16V at 3.13A provided the ambient temperature does not exceed 42°C.

SELV and Outputs Connected In Series:

All individual outputs are SELV. Outputs connected in series are non-SELV if the total output voltage + 30% of the highest of those outputs exceeds 60Vdc (the 30% addition allows for a single fault in any one individual channel).
If the total voltage of outputs connected in series exceeds the 60Vdc SELV limit then all outputs must be considered non-SELV.
The total voltage of outputs connected in series must not exceed 160V.

Non-SELV outputs are hazardous and must be guarded or a deflector fitted during installation to avoid a service engineer making inadvertent contact with the output terminals, or dropping a tool onto them.
All outputs have operational spacings to earth, and due consideration must be given to this in the end product design.

Technical Considerations

- Equipment mobility : for building-in
- Connection to the mains : Connection to mains via host equipment, or via appliance inlet
- Operating condition : continuous
- Access location : for building-in
- Over voltage category (OVC) : OVC II
- Mains supply tolerance (%) or absolute mains supply values : +10%, -10%
- Tested for IT power systems : Yes (Norway only)
- IT testing, phase-phase voltage (V) : 230V
- 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) : 5000m
- Altitude of test laboratory (m) : 64m
- Mass of equipment (kg) : 0.89 kg for basic unit without additional modules, (max 1.1kg fitted with additional modules and sub-assemblies)
- The product was submitted and evaluated for use at the maximum ambient temperature (Tma) permitted by the manufacturer's specification of: 50°C at full load to 65°C maximum (see model configuration and output details for models and conditions to which the extended ambient applies. Model RA-PFC-001 was tested with 50°C max. ambient temperature.
- The product is intended for use on the following power systems: TN
- The equipment disconnect device is considered to be: Appliance inlet (if fitted), or provided by the end equipment.
- The product was investigated to the following additional standards: CSA C22.2 No. 60950-1-07 + A2:2014, UL 60950-1 2nd Ed. Revised 2014-10-14, 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).
- 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
- All models are suitable for use at an altitude of 5000 metres.
- Multilayer PWB's accepted under CBTR Ref. No. E349607-A23 dated 2014-07-31 and letter report, see enclosure 8-08 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:

- 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: NV700 Range Primary-SELV: 363 Vrms, 650 Vpk. Primary-Earthed Dead Metal: 343 Vrms, 622 Vpk. RA-PFC-001: Primary-Earthed Dead Metal: 240 Vrms, 430 Vpk. Primary-SELV: 240V rms, 502 Vpk,
- The following secondary output circuits are SELV: - all
- The following secondary output circuits are at hazardous energy levels: 12BH, 24BH, 12C, 16C, 24C, 30C, 12CM, 16CM, 24CM and 30CM modules and primary output of model RA-PFC-001.
- The following output terminals were referenced to earth during performance testing: : All secondary outputs and their return lines individually referenced to obtain maximum working voltage.
- The power supply terminals and/or connectors are: Suitable for factory wiring only with the exception of models fitted with option 1, IEC60320 inlet (end face with fan) which are allowed to be accessible.
- 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 end-product enclosures are required: Mechanical, Fire, Electrical
- The following components require special consideration during end-product Thermal (Heating) tests due to the indicated maximum temperature measurements during component-level testing: Converter: L1 (130°C), L2 (155°C), L3 (155°C), T1 (130°C), C1 (100°C), C3 (100°C), C4 (100°C), RL1 (100°C); Modules: TX1 (130°C), TX2 (130°C), XL1 (125°C), B, BH & DB module L1 (130°C), C & CM Module L1 (140), Global Option T2 (130°C), All electrolytic capacitors (105°C)
- The RA-PFC-001 output has a hazardous Voltage.
- The following magnetic devices (e.g. transformers or inductors) are provided with OBJY3 insulation system with the indicated rating greater than Class A (105°C): T1, T2, TX1 & TX2 (all class F). See table 1.5.1 for details of insulation systems used.

Additional Information

Customer Air Cooling:

The following method must be used for determining the safe operation of PSUs when C or U options (Customer Air) are fitted, i.e. fan not fitted to PSU. The minimum permitted airflow for customer air cooling is 0.5m/s.

For PSUs and assemblies cooled by customer supplied airflow the components listed in the following table must not exceed the temperatures given. Additionally ratings specified for units with an internal fan shall still be complied with, e.g. mains input voltage range, maximum output power, module voltage / current ratings and maximum ambient temperature. To determine the component temperatures the heating tests shall 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/assembly 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/assembly. To determine the most adverse conditions consideration shall be given to the end use equipment maximum operating ambient, the PSU/assembly loading and input voltage, ventilation, end use equipment orientation, the position of doors & covers, etc. Temperatures shall 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 shall be run until all temperatures have stabilised.

Max

Circuit Ref.	Description	Temperature (°C)
L2, L3	Filter/PFC assy: Choke winding	155
C1, C3, C4	Filter/PFC assy: X capacitors	100
L1	Filter/PFC assy: Boost choke winding	130
C12, C13	Filter/PFC assy: Electrolytic capacitor	105
T1	Filter/PFC assy: Flyback transformer winding	130
RL1	Filter/PFC assy: Relay	100
TX1, TX2	Modules: Power transformer windings	130
L1, XL1	B, BH & DB module chokes	125
L1	C & CM module chokes	140
T2	Global Options: Transformer winding	130
Various	All other choke & transformer windings	110
Various	All <=10mm diameter electrolytic capacitors	105
Various	All 12.5mm diameter electrolytic capacitors	105

This report to include IEC60950-1 + A1 + A2, is a reissue of CBTR Ref. No. E135494-A53-CB-2 dated 2013-03-19 including amendments and corrections with CB Test Certificate Ref. No. DK-27353-A1-UL dated 2013-03-19. 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.
Only the tests below were deemed necessary.
The original report was modified on 2014-10-08 to include the following changes/additions:-
1. Addition/deletion of multilayer PWBs to critical component list
2. Alternative input connector (J1) same ratings, no testing considered.
3. Critical component certificate updates
4. Correction/addition to critical component list
5. Product assessed to 5000m
6. Enclosures updated to include revised handbook, drawings and marking plate
7. Alternative fuse (F2 (Daito)) tested
8. Alternative fan (YS Tech) tested
9. Assessed to IEC60950-1 amendment 2:2013
10. Cemented joint test updated

Project 4787707401 information:
This is Amendment 1 to the CB Test Report E135494-A53-CB-3 dated 2014-12-05 with CB Test Certificate DK-42330-UL and with Correction 1 dated 2014-12-09. This Amendment is published due to changes provided in Report Summary.
No additional testing has been done.
This amendment shall be read in conjunction with Original Test Report and Test Certificate and with previous Correction 1.

Additional Standards

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