

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 Switch Mode Power Supply
Model:	NV700x or NV-700x Series followed by abcd RA-PFC-001 May be prefixed by SP followed by / or – (SP represents a sales code) (may be prefixed by NS – # / or – where # may be any characters indicating non-safety related model differences. Units may be additionally marked with a product code: K7x or NV7x where x may be up to any six letters and/or numbers 0 to 9. x = H or blank for hold up option a = S, C or U for airflow option b = S or I for input option c = S,M,L,R or T for leakage option d = optionally followed by EN#V, EN*V, IN#V, IN*V, ES#V, ES*V, IS#V, IS*V where # represents standby output voltage of 5-5.5V and # represents standby output voltage of 12-13.5V followed by up to 4 modules
Rating:	NV700 or NV-700 series : 100-240Vac nominal, 47-440Hz, 11A rms max (see Model Differences for details of model ratings) RA-PFC-001: Input: 100-240Vac nominal, 47-63Hz, 11A rms max. Output: 350Vdc, 2.3A max

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: Paul Wan / Project Handler

Reviewed By: Steve Chiu / 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).

May be prefixed by SP followed by / or - (SP represents a sales code)

Unit Configuration (Description) Code:

NV-700x or NV7x (these models are identical) followed by abcd

Where x = H for high hold up or blank

a) followed by: S or C or U

where

S = Forward airflow, standard fan

C = Customer air, fan not fitted

U = Customer air, fan not fitted, cover not fitted

b) followed by: S or I

where

S = Screw input terminals

I = IEC input

c) 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.

d) 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 ES1 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 ES1.

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 signaling 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 50°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
	24	24 - 28	12.5 - 15.5V: Linearly derate from 13 to 10A 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.

Outputs Connected In Series:

All individual outputs are ES1 (except 24V DB CH2 which is ES2). Outputs connected in series are >ES1 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 ES1 limit then all outputs must be considered >ES1.

The total voltage of outputs connected in series must not exceed 160V.

All outputs have operational spacings to earth, and due consideration must be given to this in the end product design.

Note: Series connection of one NV700 unit to another NV700 unit is not permitted.

Test Item Particulars

Product group	: built-in component
Classification of use by	: Ordinary person Skilled person
Supply Connection	: AC Mains
Supply tolerance	: +10%/-10%
Supply connection – type	: pluggable equipment type A - appliance coupler 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
Special installation location	: N/A
Pollution degree (PD)	: PD 2
Manufacturer’s specified Tma (°C)	: 50°C (full load at 100-240Vac), 65°C (Output power decreased linearly by 2.5%/°C above 50°C or above 45°C for 90-99.9V) (see model differences)
IP protection class	: IPX0
Power systems	: TN
Altitude during operation (m)	: 5000 m
Altitude of test laboratory (m)	: 2000 m or less
Mass of equipment (kg)	: 0.89 kg for basic unit without additional modules, (max 1.1kg fitted with additional modules and sub- assemblies)

Technical Considerations

- 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
- Mains supply tolerance (%) or absolute mains supply : +10%/-10%
- The equipment disconnect device is considered to be : Appliance inlet (if fitted), or provided by the end equipment.
- The following were investigated as part of the protective earthing/bonding : Printed wiring board trace (refer to Enclosure 05-01, 05-02 - 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 standard : CSA/UL 62368-1:2019, , EN IEC 62368-1:2020+A11:2020, , AS/NZS 62368.1:2022
- Multilayer PWB's accepted under CBTR Ref. No. E349607-A23 dated 2014-07-31 and letter report, see enclosure 8-08 of this report.
- All models are suitable for use at an altitude of 5000 meters.

- 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.
- For heating test, the PSU was evaluated at +10%/-10% at full load at 50°C (or 65°C at derated load). Other result at 45°C below 100Vac tested for reference only, this can be considered and evaluated in the end use application allowing for specific load conditions.

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 product-line tests are conducted for this product : Earthing Continuity, Electric Strength
- The end-product Electric Strength Test is to be based upon a maximum working voltage of : NV700 Range Primary-Secondary Circuits: 363 Vrms, 650 Vpk. Primary-Earthed Dead Metal: 343 Vrms, 622 Vpk. RA-PFC-001: Primary-Earthed Dead Metal: 240 Vrms, 430 Vpk. Primary-Secondary Circuits: 240V rms, 502 Vpk,
- The following output circuits are at ES1 energy levels : all except 24V DB CH2 which is ES2.
- The following output circuits are at ES2 energy levels : 24V DB CH2
- The following output circuits are at PS3 energy levels : All outputs (by the Manufacturers declaration)
- 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 input terminals/connectors must be connected to the end-product supply neutral : N
- The following end-product enclosures are required : Fire, Mechanical, Electrical
- The following magnetic devices (e.g. transformers or inductor) are provided with an OBJY2 insulation system with the indicated rating greater than Class A (105°C) : T1, T2, TX1 & TX2 (all class F). See table 4.1.2 for details of insulation systems used.
- 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). Also, Refer to additional application considerations.
- The equipment is suitable for direct connection to : AC mains supply (for models fitted with an IEC60320 inlet)
- The power supply was evaluated to be used at altitudes up to : "5,000 m"
- 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 RA-PFC-001 output has an ES3 voltage and must not be made accessible to an end user in the end equipment.
- When operated at a frequency greater than 60Hz, evaluation of the end equipment against the requirements of clause 5.7 must be considered.

Additional Information

This report is based on previously conducted testing (as listed below) and the review of product construction of original CBTR Ref. No. E135494-A6039-CB-1, dated 2020-04-17, CBTC Ref. No. DK-96012-UL issued date 2020-04-20, CBTR Ref. No. E135494-A6039-CB-1, Correction 1 dated 2022-08-19 and CBTR Ref. No. 1-E135494-A6039-CB-1-Amendment-1, dated 2022-12-13, CBTC Ref. No. DK-96012-M1-UL issue date 2022-12-14.

Refer to Section “Test performed (name of test and test clause)” covering all applicable performance tests and rationale for waived tests.

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 IEC62368-1. 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.


Circuit Ref	Description Max	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 capacitors	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

Additional Standards

The product fulfills the requirements of: CSA/UL 62368-1:2019, EN IEC 62368-1:2020+A11:2020, AS/NZS 62368.1:2022 , J62368-1(2023)

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)"
<p>Special Instructions to UL Representative</p> <p>Sub-assemblies built at TRIO Engineering Co. Ltd. (PANYU TRIO MICROTRONICS CO LTD) are to be constructed in accordance with this Follow-Up Service Procedure. Sub-assemblies sent to final assembly locations shall be marked with a yellow dot. This identification code is to indicate to the field representative at the final assembly locations that the sub-assemblies were inspected in TRIO Engineering Co. Ltd (PANYU TRIO MICROTRONICS CO LTD). If variations are found, the code shall be removed by the manufacturer. Inspect the transformer(s) listed in Production-Line Testing Requirements (Electric Strength Test Special Constructions) per BD1.1. When the tests are conducted at other location, inspect test record and specification sheet provided by the component manufacturer. Verify the specification sheet indicates 100%.</p>	