

Description**UL TEST REPORT AND PROCEDURE**

Standard:	ANSI/AAMI ES60601-1:2005/(R)2012, CSA CAN/CSA-C22.2 NO. 60601-1:14
Certification Type:	Component Recognition
CCN:	QQHM2, QQHM8
Complementary CCNs:	
Product:	Switch Mode Power Supply
Model:	XMS350 or XMS-350 and XMS500, XMS-500, XMS500P, XMS-500P, XMS500A, XMS500AP series switch mode power supplies
Rating:	XMS350, XMS-350: 100-240Vac nom., 47-63Hz, 5.3A rms max. XMS500, XMS-500, XMS500P, XMS-500P, XMS500A, XMS500AP: 100-240Vac nom., 47-63Hz, 7A rms max. (see report Model Differences for details of nomenclature)
Applicant Name and Address:	TDK-Lambda UK Ltd Kingsley Avenue 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.

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Reviewed by: Mona Nielsen (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

XMS350 or XMS500 series switch mode power supplies
(See Model Differences for details of nomenclature)

The series consists of two power outputs, a 350W and 500W, these use the same topology with some component variations.

The XMS series switch mode power supply consists of:

1. Input filter, consisting of the input fuse(s), X and Y capacitors, common mode chokes up to the bridge and series choke after the bridge.
2. PFC (boost circuit), consisting of the boost choke and associated switching FETs/circuitry.
3. Forward converter, consisting of the main transformer and switching FETs/circuitry supplying channel 1 and fan supply outputs.
4. Standby circuit, consisting of the standby transformer and switching IC/circuitry supplying the standby output.
5. Secondary circuits (SELV), consisting of channel 1 output, standby output, fan supply, power OK and inhibit/enable.

Refer to the Report Modifications page for any modifications made to this report.

Model Differences

XMS350 or XMS500 series (may also be marked as XMS-350 or XMS-500) as described below:

Units may be marked with a Product Code: Xy where y may be any number of characters.

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

Unit Configuration Code (Description): may be prefixed by SP followed by / or - (SP represents a sales code)

Unit Configuration (Description)

XMSxy-a-bc-defghijklm

where:

x = 350 for 350W model

500 for 500W model

500A for enhanced 500W model (less than 1W inhibited)

500P for 576W peak power models (36, 40V and 48V output models only)

500AP for enhanced 500W model with 576W peak power (36V, 40V, 48V output models only)

y = Blank for Class I
D for Class II

a = Channel 1 Output Voltage (see Ch1 in the table below, adjustment range column).

b = Standby Output Voltage: see standby voltage in table below
N for no supply
5 for 5 volt
12 for 12 volt

c = Standby Output Current†:
C for 0.5A
M for 1.0A
H for 2.0A
N for no supply or 0 amps output

d = Fan Supply†:
N for no fan supply (customer cooling)
N1 for 24V fan supply (customer cooling)
N2 for 12V variable supply
N3 for 12V fixed supply
KF for non-standard top fan
TF for top-fan

e = U for non-standard U chassis
P for perforated frame
N for Open Frame
C for custom chassis/covers for non-standard models
S for standard U chassis
B for standard U chassis with perforated cover

f = Touch (Enclosure) current:
B for <100uA
T for <75uA

g = Earth leakage current:
D for Class II (no Earth)
L for <300uA
R for <150uA
T for <100uA

h = E or In for inhibit
T or En for enable

i = A for AC OK option
N for no AC OK option
P for Power Good Option (XMS500A or XMS500AP models only)

j = Blank for dual fuses fitted
FL for single fuse fitted in the Live line

klm = Blank for standard output settings
May be three numbers from 0 to 9 (preceded by -) which denotes various output voltage/current settings within the specified ranges of each output for a particular unit. (may define non-safety related parameters/feature, e.g. reduced primary current limit, reduced OVP)

Input Parameters

Nominal input voltage 100 - 240 Vac

Input voltage range 85 - 264 Vac
 Input frequency range 47 - 63 Hz
 Maximum input current 7A (5.3A*) rms

* Input for 350W models.

All ratings apply for ambient temperatures up to 50°C.

At 85Vac input the following deratings apply to all XMS500 TF models: 500W output power at 40°C ambient or 400W output power at 50°C ambient

Output Parameters

†Output ratings are in accordance with the following table:

Standard models:

Output Channel	Voltage Designation	Vout nom.(V)	Adjustment Range (V)	Output Current (A)	Output Power (W)
CH1 (500W)	12	12	11.6 - 13.2	41.6	500
	24	24	23.8 - 25.2	20.8	500
	36	36	36	13.8(16*)	500(576*)
	40	40	38 - 42	12.5(15.16*)	500(576*)
	48	48	47-50	10.4(12*)	500(576*)
Standby Option	5	5	5 - 5.5	0.5	2.75
	5	5	5 - 5.5	2.0	11.0
	12	12	12-13.2	1	13.2
Fan Supply	N	-	-	-	-
	N1	24	Fixed	0.2	4.8
	N2	12	6-12	-	3.0
	N3	12	Fixed	0.25	3.0
CH1 (350W)	24	24	23.8 - 25.2	14.6	350
Standby Option	N	10	5 - 15	0	0
Fan Supply	N	-	-	-	-
	N1	24	Fixed	0.2	4.8

*576W peak power up to 2 minutes with 500Wrms power using the following formula:

$$500Wrms = ((peakpower^2 \times T1 + reducedpower^2 \times T2)/(T1 + T2))^{1/2}$$

Where T1 = peakpower time on in seconds

T2 = reducedpower time on in seconds

Non-Standard Models:

X00011# XMS350-24-NN-N1CBLEN Customer specific chassis

X00023# XMS500D-24.5-5C-KFCBDEN Customer specific top fan/chassis model

X00073# XMS500-24-NN-NCBRInA Customer specific chassis/cover

Where # can be any letter denoting non-safety related changes.

Output Limitations:

All outputs are SELV

Channel 1 is hazardous energy

Additional Information

Cooling for units with customer supplied air (all models except –TF and KF fan supply)

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:

Circuit Ref:	Description	Max. Temperature (°C) ++
J1	Input Connector	105
C7, C8	X Capacitor	100
L2, L4	Common Mode Choke Winding	130 (145)
L6	Series Mode Choke Winding	130
ASY5 D7	Bridge Diode	125 (130)
C14, C11, C21, C22, C10, C23, C24, C6, C18 (++)	Y Capacitors	100
C26	Capacitor	85 (105)
RLY1	Relay	100
U1, U2, U5, U6, U7 (++)	Opto-Coupler	100
TX1 (Standby)	Windings and core	120 (130)
TX3 500W	Windings and core	120 (130)
TX3 350W	Windings and core	100 (110)
ASY6 Q3	Boost FET	127 (130)
ASY4 Q1	Forward FET	127 (130)
ASY3 Q4	Output FET	127 (130)
C13	Boost Capacitor	80 (105)
C9	Boost Capacitor	70 (105)
L3, L5	Boost Choke Winding	130 (140)
L7	Channel 1 Output Choke	130 (140)
C4, C5, C15, C16, C17 C19, C20 (++)	Electrolytic Capacitors	80 (105)

+ The higher temperature limits in brackets may be used but product life may be reduced.

++ When fitted

Amendment 1 (project #4787185482):

This report is the 1st amendment to the original CBTR Ref. No. E349607-D1000-CB-1 dated 2015-06-11 with CB Test Certificate DK-49679-UL dated 2015-06-11.

This E349607-D1000-1/A1/C0 amending Test Report shall be read and reproduced only in conjunction with Original Test Report.

Based on 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.

The original report was modified to include the following changes/additions:

- 1) CH1, 48V unit assessed (CH1 output voltage rated 48V added)
- 2) Standby, 12V, 1A and 5V, 2A assessed (new ratings of standby output)

- 3) Variable speed fan assessed
- 4) Perforated chassis assessed
- 5) Bypass capacitors assessed (C23, C24 added to CCL)
- 6) Critical components updated
- 7) Enclosures updated
- 8) Add standard top fan
- 9) Add standard U chassis
- 10) CBTL changed to CBTL Denmark
- 11) Models designations description revised

Amendment 2 (project #4787424006):

This report is an amendment to CBTR Ref. No. E349607-D1000-1-CB dated 2015-06-11 including E349607-D1000-1/A1/CO-ULCB amendment 1 dated 2016-02-15 with CB Test Certificates DK-49679-UL dated 2015-11-09 and DK-49679-A1-UL dated 2016-02-24.

This E349607-D1000-1/A2/C0 amending Test Report shall be read and reproduced only in conjunction with Original Test Report and previous Amendment.

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 and only limited testing was required.

The original report was modified on 2016-06-03 to include the following changes/additions:

- 1) CH1, 12V unit assessed
- 2) Critical components updated/corrected (added C21 and C22 input to chassis Y capacitors)
- 3) Enclosures updated
- 4) XMS350 input current rating corrected to 5.3A
- 5) Added N3 option (as N2 but fixed 12V standby output)
- 6) Added standard 12V top fan
- 7) Clause 15.5.2 corrected
- 8) Table 8.8.3 corrected to include Z primary to secondary

Amendment 3 (project #4787696215):

This report E349607-D1000-1/A3/C0 is the 3rd amendment to CBTR Ref. No. E349607-D1000-1-CB dated 2015-06-11 with amendment 1 dated 2016-02-15 and amendment 2 dated 2016-08-11.

This E349607-D1000-1/A3/C0 amending Test Report shall be read and reproduced only in conjunction with Original Test Report and previous Amendments.

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 and only limited testing was required.

The original report was modified to include the following changes/additions:

1. Addition of alternates to the CCL.
2. Corrections to CCL.
3. Add alternate TX1 flyback transformers
 - 230295 (5V, 0.5A)(winding position changes for EMC)
 - 230294 (5V, 2A), (adding foil for EMC)
 - 230287 (12V, 1A), (winding position changes for EMC)
4. Add alternate GUL wing Lexan insulator
5. Nomenclature changes:
 - g = T for <100uA
 - h = T or En for enable
 - E or In for inhibit
6. XMS500 40V and 48V models add peak power of 576W up to 2 mins
7. C7 X capacitor value increased to 470nF max

8. Add alternate L2 common mode choke

Amendment 1 (Project# 4788143479)

This report is an amendment to CBTR Ref. No. E349607-D1000-2/A0/C0-ULCB dated 2017-07-24 with CB Test Certificates DK-65446-UL dated 2017-06-25.

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 and only limited testing was required.

The original report was modified on 2017-11-09 to include the following changes/additions:

1. Addition of alternates to the CCL, add L4 to alternate L2 common mode choke and Rynite base E41938
2. Corrections to CCL. (Rynite UL CCN code)
3. Add X00073# (where # may be any letter) to non-standard models.
4. Add X00073# Gap-pad to CCL
5. Add Nomenclature change:
e = B for standard U chassis with perforated cover
6. Add X00073# Gap-pad drawings to Enclosures
7. Add X00073# chassis and cover drawings to Enclosures
8. Replace the following Enclosures with updated Enclosures:
diagrams 01, 04, 09
manuals 01
miscellaneous 07
9. Add new Enclosures:
photographs 06, 07
diagrams 10 – 14

Amendment 2 (Project#4788477050)

This report is an amendment to CBTR Ref. No. E349607-D1000-2/A1/C0-ULCB dated 2017-12-18 with CB Test Certificate DK-65446-A1-UL dated 2017-12-18.

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 and only limited testing was required.

1. Addition of alternate capacitors and discharge resistors in the Critical Components Table
2. Amendments to the Critical Components Table to update component certificate numbers and include standard editions and issue dates
3. Update the enclosures to include diagrams, revised manual & PWB layouts and deleted License documents where they are no longer applicable to this product.
4. Evaluate the Clearance requirements of the PSU for use at 4000m
5. Correction to the report to include nomenclature update for "B" under option "e" which was omitted from the previous publication and exclude model "TF" in the Additional Information for units with customer supplied air.

Amendment 3 (Project# 4789460918).

This report is an amendment to CBTR Ref. No. E349607-D1000-2/A2/C1-ULCB dated 2018-05-21 with CB test certificate DK-65446-A2-UL dated 2018-05-21.

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 and only limited testing was required.

The report was modified to include the following changes/additions:

1. Addition of XMS500AXMS500P, XMS-500P, XMS500AP models including relevant testing and modifications to the CCL and Enclosures
2. Verification of 85V input rating for all XMS models.
3. Addition of alternative fuse including relevant testing and modifications to the CCL
4. Addition of alternate factory address
5. General updates to enclosures

Technical Considerations

- The product was investigated to the following additional standards: EN 60601-1:2006/ A11:2011/ A1:2013/ A12:2014 (IEC60601-1, Edition 3.1), ANSI/AAMI ES60601-1:2005/(R)2012 and A1:2012,, C1:2009/(R)2012 and A2:2010/(R)2012 Medical Electrical Equipment - Part 1 (IEC 60601-1:2005, Mod), CAN/CSA-C22.2 NO. 60601-1:14 - Medical electrical equipment - Part 1 (Adopted IEC 60601-1:2005, third edition, 2005-12, incl. Am1:2012, with Canadian deviations), Third Edition
- The following additional investigations were conducted:
- The product was not investigated to the following standards or clauses: Biocompatibility, PESS, EMC, Annex Z of EN standards for compliance with the MDD
- The following accessories were investigated for use with the product:
- The product was tested for use at the maximum ambient temperature (T_{ma}) 50°C in normal conditions permitted by the manufacturer, see Additional Information for details.

EMC compliance has not been verified nor has it been taken into consideration. An accredited EMC Test Report will be required in conjunction with the Certification of the end product.

Multilayer PWB's accepted under CBTR Ref No. E349607-A23 dated 2014-07-31 and letter report in Enclosure 8-07 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 (except XMSxD model)

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 output, 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: 20A

The investigated Pollution Degree is: 2

Open frame models, H3 is connected to the input connector earth (not applicable to XMSxD model)

Proper bonding to the end-product main protective earthing termination is: Required (except XMSxD model)

The following magnetic devices (e.g. transformer or inductor) are provided with an OBJY2 insulation system with the indicated rating greater than Class A (105°C): TX1 (Class F), TX3 (Class B or F) see Critical Component List for details of insulation systems used.

The following end-product enclosures are required: Mechanical, Fire, Electrical

All models require component temperatures monitored as detailed in the Additional Information (except KF and TF fan models)

The end-product Electric Strength Test is to be based upon a maximum working voltage of: Primary-SELV:405Vrms, 655Vpk, Primary-Earthed Dead Metal: 365Vrms, 632Vpk

An investigation of the protective bonding terminals has: been conducted.

Output circuits have not been evaluated for direct patient connection (Type B, BF, CF)

Considerations to the applied parts requirement, to be conducted as end-product.

End product Risk Management Process to be performed to include consideration of requirements specific to the Power Supply.

Markings and instructions	
Clause Title	Marking or Instruction Details
Company identification	Classified or Recognized company's name, Trade name, Trademark or File
Model	Model number
Serial number or lot or batch identifier	Serial number or lot or batch identifier
Supply Connection	Voltage range, ac/dc, phases if more than single phase
Supply Frequency	Rated frequency range in hertz
Power Input	Amps, VA, or Watts
Output	Rated output voltage, power, frequency.

Special Instructions to UL Representative
None

Production-Line Testing Requirements		
Test Exemptions - The following models are exempt from the indicated test		
Test	Exemption Specifics	Details
Grounding Continuity	The following models are exempt from the indicated test:	XMSxD models (Class II)
Dielectric Voltage Withstand	The following models are exempt from the indicated test:	N/A (no exemptions)
Patient Circuit Dielectric Voltage Withstand	The following models are exempt from the indicated test:	All models exempt.
Solid-State Components	The following solid-state components may be disconnected from the remainder of the circuitry during either Dielectric Voltage Withstand Test:	N/A

Sample and Test Specifics for Follow-Up Tests at UL			
The following tests shall be conducted in accordance with the Generic Inspection Instructions			
Plastic Enclosure or Part	Test	Sample(s)	Test Specifics
None	NA	NA	NA
