Tehran Urban & Suburban Railway Operation Company

Metro Cars Propulsion Design & Production Project

ACM Type Test procedure

JDEVS-MPDP-AC-PD-208-00

JAHAD DANESHGAHI ELM VA SANNAT
November 2020

1							
0	Nov 2020	Issue for Comment	B.Nikmaram	A.Hassanzadeh	M.Ghorbanali	M.Fazeli	M.Farzi
REV.	DATE	DESCRIPTION	Author(s)	Prepare	Check	Confirm	Approve

Address: No.188 – MALEKLOO St. – South of Iran University of Science and Technology – North HEYDARKHANI St. – FARJAM St. – NARMAK – TEHRAN.
Phone: +982177455001-2 Email: info@jdevs.ir

SHEET	REVISION					REMARK	SHEET	REVISION					REMARK	SHEET	REVISION					REMARK
	0	1	2	3	4			0	1	2	3	4			0	1	2	3	4	
1	X						31							61						
2	X						32							62						
3	X						33							63						
4	X						34							64						
5	X						35							65						
6	X						36							66						
7	X						37							67						
8	X						38							68						
9	X						39							69						
10	X						40							70						
11	X						41							71						
12	X						42							72						
13	X						43							73						
14	X						44							74						
15	X						45							75						
16	X						46							76						
17	X						47							77						
18	X						48							78						
19	X						49							79						
20	X						50							80						
21							51							81						
22							52							82						
23							53							83						
24							54							84						
25							55							85						
26							56							86						
27							57							87						
28							58							88						
29							59							89						
30							60							90						

Table of contents

1. Introduction

This document describes the test procedure for the auxiliary converter module (ACM) in the Propulsion System.

2. Applicable standards

The following standards are applied to this system.

Table 1- Applicable standards

Doc. & Drwg. #	Title or description	Remarks
IEC 61287-1	Power converters installed on board rolling stock	Railway applications
EN 50207	Electronic power converters for rolling stock	Railway applications
IEC 60850	Supply voltages of traction systems	Railway applications
IEC 61377-1	Determination of sound levels	Power transformers
IEC 62236-3-2	Electromagnetic compatibility	Railway applications

3- Test equipment required

The combined test is performed using the following equipment.

Table 2- Required Test Equipment (plan)

Instrument	**Manufacturer**	**Model / Serial No.**	**calibration expiration date**
Weight Measurement	PAND industries	203261	
Wind intensity measurement	PROVA	10180508	2023/08/14
POWER AND QUALITY ANALYSER	CHAUVIN ARNOUX	C.A 8336	2023/05/12
Infrared Thermometer	CHAUVIN ARNOUX	C.A1862	2023/04/25
Current Clamp	CHAUVIN ARNOUX	F203	
Digital Multimeter	VICTOR	VC97	2023/04/21
SOUND LEVEL METER	BENETECH	GM1356	2023/07/05
Handheld Digital Oscilloscope	GPS LTD	GPS-810i	2023/04/25
Current sensor	LEM	LA 305-S/SP19	

4- Routine test sequence

Routine test sequence is indicated in the following table.

Table 3- list of tests

NO	Type test	Subclause
1	Visual inspection	4.5.3.1
2	Marking inspection	4.5.3.4
3	Leakage test	4.5.3.5.4
4	Dielectric test	4.5.3.7
5	Insulation resistance test	4.5.3.8
6	Tests of mechanical and electrical protection and measuring equipment	4.5.3.9
7	Light load test	4.5.3.10

4-1- ACM routine test procedure

This section describes the steps and how to perform the routine tests of the ACM.

4-1-1- Visual inspection

The object of the visual inspection is to prove that the converter is free from physical defects and that surface treatments have been duly carried out.

this test includes checking these components:

1. All internal and interface electrical and mechanical components.
2. All internal and interface electrical and mechanical connections.
3. Electrical and mechanical connectors have been assembled correctly.
4. Connections between components follow the specified routes.

4-1-2- Marking inspection

The converter shall be provided with a nameplate which shall be readable during the useful life of the converter and on which at least the following is inscribed:

1. manufacturer's mark
2. serial number
3. year of manufacture
4. mass
5. specified input and output value

4-1-3- Leakage test

Where closed-circuit fluid cooling is employed, a leakage test shall be performed to prove that no leakage occurs in the complete cooling system.

4-1-3-1- How and steps to perform the test

By rotating the anemometer around the outside of the ACM box, no air leakage should be observed other than the outlet wind from the outlet valve of the ACM box.

4-1-4- Dielectric test

Dielectric tests are carried out to verify the correct state of a completely assembled converter. They are not carried out to verify the insulation of elementary components or clearances and creepage distances.

4-1-4-1- How and steps to perform the test

This test is performed by equipping a digital resistive voltage test.
steps to perform the test:

1. DC and AC terminals of the converter shall be connected to each other.
2. No circuit part of the converter shall be left floating during the test.
3. Motors or fans shall be grounded during the dielectric test.
4. Detach the control board and gate drive units for extra caution.
5. Gate-emitter of all IGBTs shall be connected to each other.
6. If any component or subassembly is not submitted to the dielectric test of the converter, its terminals shall be grounded.
7. Y-capacitors in EMC filters shall be disconnected.
8. According to IEC 62497-1:2010, First, a DC voltage of 1.9 kV is applied between the terminals and the body. after that, an AC voltage with a 1.9 kV peak is applied between the terminals and the body.
9. In order to prevent pre-damages of increasingly used solid insulation, the test voltage should be applied for only 10 s.
10. If the chosen test method is power frequency and if the test has to be repeated, the test voltage shall be reduced to 80 % of the initial test voltage.
11. The test is declared successful if no dielectric fault occurs.

4-1-5- Insulation resistance test

One minute after the dielectric test, the insulation resistance shall be measured by applying a DC voltage.

4-1-5-1- How and steps to perform the test

steps to perform the test:

1. DC and AC terminals of the converter shall be connected to each other.
2. No circuit part of the converter shall be left floating during the test.
3. motors or fans shall be grounded during the dielectric test.
4. Detach the control board and gate drive units for extra caution.
5. Gate emitter of all IGBTs shall be connected to each other.
6. If any component or subassembly is not submitted to the dielectric test of the converter, its terminals shall be grounded.
7. Y-capacitors in EMC filters shall be disconnected.
8. According to IEC 62497-1:2010, First, a DC voltage with 0.9 kV amplitude is applied between the terminals and the body.
9. The insulation resistance shall be not less than 1 MΩ for rated insulation voltages not exceeding 1 kV.

4-1-6- Tests of mechanical and electrical protection and measuring equipment

4-1-6-1- steps to perform the Tests of mechanical and electrical protection and measuring equipment

1. Connect the ACM to the 750 v DC line.
2. Examine function of the output AC switch (ABB switch) through connecting and disconnecting of this switch.
3. Apply the output nominal AC and DC load and check the performance of the sensors with calibrated measuring device.

4-1-7- Light load test

This test is to verify that the power circuits of the converter function properly. During the test the complete converter is supplied according to the nominal input voltage and is operated with an output current with different sizes. All signal and power outputs of the converter shall be checked. This test is a short-time test at less than rated output power and is not intended for temperature rise.

4-1-7-1- How and steps to perform the test

1. Connect the ACM to the 750 v DC line.
2. apply a 10 KW load and register value of the input voltage, input current and input power and output voltage, output current and output power.
3. apply a 50 KW load and register value of the input voltage, input current and input power and output voltage, output current and output power.
4. apply a 80 KW load and register value of the input voltage, input current and input power and output voltage, output current and output power.

5-Type test sequence

The test sequence is indicated in the following table.

Table 4- list of type tests

NO	Type test	Subclause
1	Verification of dimensions and tolerances	4.5.3.2
2	Weighing	4.5.3.3
3	Cooling system performance tests	4.5.3.5
4	Commutation test	4.5.3.11
5	Acoustic noise measurement	4.5.3.12
6	Temperature-rise test	4.5.3.13
7	Power loss determination	4.5.3.14
8	Supply overvoltage and transient energy test	4.5.3.15
9	Sudden variations of load	4.5.3.16
10	Short-time supply interruption test	4.5.3.21
11	Voltage and frequency ranges verification	7.5.5
12	Starting and restarting test	7.5.3
13	Tests of mechanical and electrical protection and measuring equipment	4.5.3.9
14	Output characteristic test	7.5.2
15	Overload capability test	7.5.6
16	Safety requirements inspection	7.5.3.17
17	Step change of line voltage test	4.5.3.20

5-1- Type test procedure
This section describes the steps and how to perform the type tests of the ACM.

5-1-1- Verification of dimensions and tolerances
Dimensions and their tolerances shall be checked.

5-1-1-1- steps to perform the test
Check all the dimensions of the ACM box provided in Document JDEVS-MPDP-AC-PD-201 in Section 5-1 with the metering tool. Measured value should be written on the prepared diagram of the ACM box with a blue pen.

5-1-2- Weighing
weight is specified in the contract, so the converter shall be weighed.

5-1-2-1- steps to perform the test
1. All ACM connections must be opened.
2. Attach the scales to the overhead crane.
3. Attach the converter to the scale with the help of the load belt and read its weight.

5-1-3- Cooling system performance tests
This test may be performed either on a complete converter or on a partially finished converter which is representative of a finished converter. The object of this test is to measure the flow of the cooling medium passing through the various components concerned and to verify whether it complies with the specified flow.

5-1-3-1- steps to perform the test
1. the average air velocity passing through large and small heat sinks should be measure at 5 points.
2. Calculate the level of air passage through each heatsink.
3. Calculate the flow rate of air passing through each heatsink.
4. Estimate the space around the transformer and input and output inductor for air passage.
5. Calculation of the average speed of air passing around the target equipment.

5-1-4- Commutation test

This test is carried out to verify that the converter will commutate the specified maximum instantaneous current.

5-1-4-1- steps to perform the test

1. Connect the converter to the 750 V DC line.
2. Connect the three-phase AC load to the AC output of the converter.
3. After starting the converter, increase the AC output load in steps and bring it to the value above 105 kW specified in the contract.
4. Measure and record the values three-phase of the voltage, current, and output power.

5-1-5- Acoustic noise measurement

During the test, the converter shall be in operation. For an auxiliary converter, the operating point shall be defined by the rated output power.

5-1-5-1- steps to perform the test

1. Due to the test performed in the workshop environment, the converter must be placed in the appropriate place.
2. Connect the converter to the 750 V DC line.
3. Connect the three-phase AC load to the AC output of the converter.
4. Before turning on the converter, calculate the average background noise at least 10 predetermined points at a distance of one meter from the converter ($\bar{L}_{bgA}$).
5. Turn on the converter and regulate the output AC load in nominal value.
6. The device fan should be set to slow speed and the average sound of the converter calculated at the same 10 points as before ($\bar{L}_{pA-L}$).
7. The device fan should be set to high speed and the average sound of the converter calculated at the same 10 points as before ($\bar{L}_{pA0\_H}$).
8. The value of the converter sound is calculated by removing the background noise and should be compared with the set value ($\bar{L}_{pA}$).

5-1-6- Temperature-rise test

The temperature, of listed components shall be measured when the converter is subjected to the load profile or to equivalent conditions.

5-1-6-1- steps to perform the test

1. Connect the converter to the 750 V DC line.
2. AC and DC outputs of the converter should be connected to the load.
3. Turn on the converter and set the output load on the nominal value.
4. Should be created a partial list of the specified components and the temperature of these components should be measured every 20 minutes.
5. The duration of this test should be such that the temperature of the desired parts reaches a constant value and does not change.
6. Create a diagram or table of the recorded temperature and present it.

5-1-7- Power loss determination

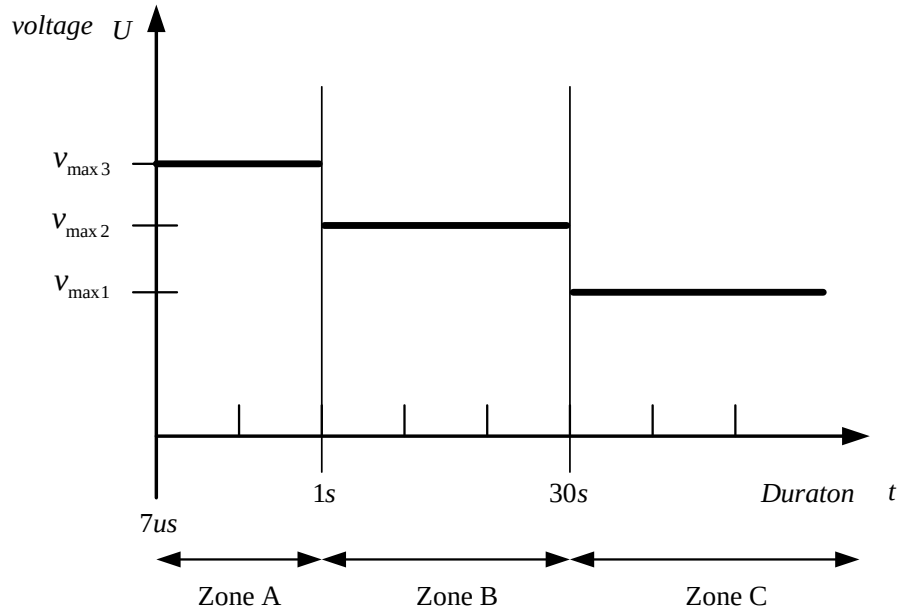
This test is carried out to calculate the power efficiency.

5-1-7-1- steps to perform the test

1. Connect the converter to the 750 V DC line.
2. Connect the three-phase AC load to the AC output of the converter.
3. Set output load in nominal value.
4. Input voltage and current of the converter should be measured.
5. Calculate the input power of the converter.
6. Output power of the converter should be measured.
7. The efficiency of the converter calculated through input power and output power.

5-1-8- Supply overvoltage and transient energy test

It shall be confirmed that the converter is able to withstand overvoltage and transient energy surges. This test is performed in three zones. The test zones and the amount of rated voltage are shown in the below diagram.



Zone A: Blocking level 2 High Voltage ($v_{max\,3}$) duration 1s 1000 VDC

Zone B: Blocking level 1 High Voltage ($v_{max\,2}$) duration 30s 950 VDC

Zone C: Maximum Voltage Full Performance 900 VDC

5-1-8-1- steps to perform the zone A test

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 530 v than through connection to the 12-pulse diode rectifier created an upper than 1000 v DC.
5. Connect the created DC voltage to converter.
6. Turn on the converter.
7. See output voltage and output current of the ACM that converter should be turnoff after one second.

5-1-8-2- steps to perform the zone B test

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 440 v than through connection to the 12-pulse diode rectifier created an upper than 950 v DC.
5. Connect the created DC voltage to converter.

6. Turn on the converter.
7. See output voltage and output current of the ACM that converter should be turnoff after 30 seconds.

5-1-8-3- steps to perform the zone C test

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 400 v than through connection to the 12-pulse diode rectifier created a 900 v DC.
5. Connect the created DC voltage to converter.
6. Turn on the converter and apply a nominal AC and DC load to the output of the converter.
7. See output voltage and output current.
8. The converter must work continuously in this voltage without any problem in its operations.

5-1-9- Sudden variations of load

Two kinds of test can be performed:

1. short-circuit test
2. load-break test

5-1-9-1- short-circuit test

A short circuit test shall be carried out for all short-circuit protected outputs.

5-1-9-1-1- steps to perform the DC short-circuit test

1. Connect the ACM to the 750 v DC line.
2. Connect the DC output to each other via a 25-amp fuse and put the switch on state off.
3. Turn on the converter.
4. After the output of the converter arrives to steady-state, by observing safety tips, turn the switch on the on state.
5. Record the DC output voltage of the converter.

5-1-9-1-2- steps to perform the AC short-circuit test

1. Connect the ACM to the 750 v DC line.
2. Connect the three phase AC output to each other via a 25-amp fuse and put the switch on state off.
3. Turn on the converter.
4. After the output of the converter arrives to steady-state, by observing safety tips, turn the switch on the on state.
5. Record the three phase AC output voltage of the converter.

5-1-9-2- load-break test

This test is carried out to verify that the converter will not sustain any damage when the load is suddenly disconnected. The protection equipment shall be functioning.

5-1-9-2-1- steps to perform the DC load break test

1. Prepare a DC load with a specified 80% of the rated output power of the converter.
2. Connect the DC load through a switch to the converter.
3. Start the converter and apply the DC load through the switch to the converter.
4. After the converter arrives at steady-state, disconnect the DC load suddenly through the switch.
5. See and record the output DC voltage and current.

5-1-9-2-2- steps to perform the AC load break test

1. Prepare a AC load with a specified 70% of the rated output power of the converter.
2. Connect the AC load through a switch to the converter.
3. Start the converter and apply the AC load through the switch to the converter.
4. After the converter arrives at steady-state, disconnect the AC load suddenly through the switch.
5. See and record the output AC voltage and current.

5-1-10- Short-time supply interruption test

This test is provided to verify that a line voltage supply interruption of any duration does not damage the converter and the current consumption remains within the specified limits, independent of the load conditions of the converter.

5-1-10-1- steps to perform the Short-time supply interruption test

1. Connect the ACM to the 750 v DC line.
2. Turn on the converter.
3. Connect an AC load with 20 percent of the nominal value to output of the ACM.
4. Apply a three seconds interruption through an electromechanical switch on the DC link switchboard.
5. See and record the output AC voltage and current.

5-1-11- Voltage and frequency ranges verification

The combinations of input and output values to be tested shall be such that correct functioning over the whole range of operation is verified with a minimum of tests.

this test should be done in three conditions:

1. Minimum input voltage (Vin=500 v) and nominal output load.
2. Maximum input voltage (Vin=900 v) and nominal output load.
3. Rated input voltage (Vin=750 v) and overload output.

5-1-11-1- steps to perform the minimum input voltage and nominal output load test

1. Connect the 6-pulse diode rectifier directly to the three-phase line and created a 500 DC voltage.
2. Connect the output DC voltage of the rectifier to the ACM.
3. Turn on the converter and apply a nominal AC and DC load to the output of the converter.
4. Record output voltage and fundamental frequency.

5-1-11-2- steps to perform the maximum input voltage and nominal output load

9. Connect the 6-pulse diode rectifier directly to the three-phase line.
10. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
11. Connect these two rectifiers together.
12. Set the 6-pulse thyristor rectifier on 400 v than through connection to the 12-pulse diode rectifier created a 900 v DC.
13. Apply this created DC voltage to the converter.
14. Turn on the converter and apply a nominal AC and DC load to the output of the converter.
15. Record output voltage and fundamental frequency.

5-1-11-3- steps to perform the rated input voltage and overload output.

1. Connect the converter to 750 DC link voltage.
2. Turn on the converter and apply an over AC and DC load to the output of the converter.
3. record output voltage and fundamental frequency.

5-1-12- Starting and restarting test

This test shall be performed for minimum and maximum specified input characteristics.

5-1-12-1- steps to perform the Starting test in minimum input voltage

1. Connect the 6-pulse diode rectifier directly to the three-phase line and created a 500 DC voltage.
2. Connect the output DC voltage of the rectifier to the ACM.
3. Apply a 20 percent of nominal output load to the converter.
4. Turn on the converter.
5. Measure output voltage and output current of the ACM.

5-1-12-2- steps to perform the Starting test in maximum input voltage

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 400 v than through connection to the 12-pulse diode rectifier created a 900 v DC.
5. Connect the created DC voltage to converter.
6. Apply a 20 percent of nominal output load to the converter.

7. Turn on the converter.
8. Measure output voltage and output current of the ACM.

4-1-13- Tests of mechanical and electrical protection and measuring equipment

4-1-13-1- steps to perform the Tests of mechanical and electrical protection and measuring equipment

1. Connect the ACM to the 750 v DC line.
2. Apply a 10 KW load and register value of the input voltage, input current and input power and output voltage, output current and output power.
3. Examine function of the output AC switch (ABB switch) through connecting and disconnecting of this switch.
4. Apply the output nominal AC and DC load and check the performance of the sensors with calibrated measuring device.

5-1-14- Output characteristic test

This test is carried out to verify that the following electrical characteristics (where applicable) are in accordance with agreed test conditions:

- DC output:
    1. Voltage and tolerance;
    2. DC current and voltage ripple;
    3. Current and voltage limitation (if any);

- AC output:
    1. Fundamental voltage and static tolerance;
    2. Frequency and static tolerance;
    3. Total harmonic distortion ratio of voltage in specified load conditions;

this test shall be carried out:

1. At minimum, rated and maximum input voltages;
2. At minimum, rated and overload power;
3. With and without the specified asymmetrical load and/or loading of a star-point or neutral connection.

5-1-14-1- steps to perform the Output characteristic in minimum output load and nominal input voltage

1. Connect the ACM to the 750 v DC line.

2. Apply a 45% nominal value load to the AC output of the ACM.
3. Turn on the ACM.
4. Record the output power, voltage, and fundamental frequency.

5-1-14-2- steps to perform the Output characteristic in nominal output load and nominal input voltage

1. Connect the ACM to the 750 v DC line.
2. Apply a nominal value AC load to the output of the ACM.
3. Turn on the ACM.
4. Record the output power, voltage, and fundamental frequency.

5-1-14-3- steps to perform the Output characteristic in overload output and nominal input voltage

1. Connect the ACM to the 750 v DC line.
2. Turn on the ACM.
3. Apply a 110 KW load to the AC output of the ACM.
4. Record the output power, voltage, and fundamental frequency.

5-1-14-4- steps to perform the Output characteristic in asymmetrical load and nominal input voltage

1. Connect the ACM to the 750 v DC line.
2. Create an unbalanced three-phase load and apply it to the AC output of the ACM.
3. Turn on the ACM.
4. Record the output power, voltage, and fundamental frequency.

5-1-14-5- steps to perform the Output characteristic in minimum input DC voltage and nominal load

1. Connect the 6-pulse diode rectifier directly to the three-phase line and created a 500 DC voltage.
2. Connect the output voltage of the rectifier to the ACM.
3. Apply a nominal value AC load to the output of the ACM.
4. Turn on the ACM.
5. Record the output power, voltage, and fundamental frequency.

5-1-14-6- steps to perform the Output characteristic in maximum input DC voltage and nominal load

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 400 v than through connection to the 12-pulse diode rectifier created a 900 v DC.
5. Connect the output voltage of these two rectifiers to the ACM.
6. Turn on the ACM.
7. Apply a nominal value AC load to the output of the ACM.
8. Record the output power, voltage, and fundamental frequency.

5-1-14-7- steps to perform the Output characteristic in minimum DC output load and nominal input voltage:

5. Connect the ACM to the 750 v DC line.
6. Apply a 4 KW load to the DC output of the ACM.
7. Turn on the ACM.
8. Record the DC output power, DC output voltage, and DC output current.

5-1-14-8- steps to perform the Output characteristic in nominal DC output load and nominal input voltage

1. Connect the ACM to the 750 v DC line.
2. Apply a 12 KW load to the DC output of the ACM.
3. Turn on the ACM.
4. Record the DC output power, DC output voltage, and DC output current.

5-1-14-9- steps to perform the Output characteristic in overload DC output and nominal input voltage

1. Connect the ACM to the 750 v DC line.
2. Apply a 15 KW load to the DC output of the ACM.
3. Turn on the ACM.
4. Record the DC output power, DC output voltage, and DC output current.

5-1-14-10- steps to perform the Output characteristic in minimum input DC voltage and nominal load

1. Connect the 6-pulse diode rectifier directly to the three-phase line and created a 500 DC voltage.
2. Connect the output voltage of the rectifier to the ACM.
3. Apply a 12 KW load to the DC output of the ACM.
4. Turn on the ACM.
5. Record the DC output power, DC output voltage, and DC output current.

5-1-14-11- steps to perform the Output characteristic in maximum input DC link and nominal output load

1. Connect the 6-pulse diode rectifier directly to the three-phase line.
2. Connect the 12-pulse thyristor rectifier through the 12-pulse transformer to the three-phase line.
3. Connect these two rectifiers together.
4. Set the 6-pulse thyristor rectifier on 400 v than through connection to the 12-pulse diode rectifier created a 900 v DC.
5. Connect the output voltage of these two rectifiers to the ACM.
6. Apply a 12 KW load to the DC output of the ACM.
7. Turn on the ACM.
8. Record the DC output power, DC output voltage, and DC output current.

5-1-15- Overload capability test

this test shall be carried out to show the overload tolerance capability of the converter.

5-1-15-1- steps to perform the Overload capability test

1. Connect the ACM to the 750 v DC line.
2. Turn on the ACM.
3. Apply a 120% nominal value load to the output of the ACM for 10 minutes.
4. Converter should be turned off after 10 minutes.

5-1-16- Safety requirements inspection test

The inspection is provided to check that the design of the converter meets the safety standards which are specified in the contract.

5-1-16-1- steps to perform the Safety requirements inspection test

1. Connect the ACM to the 750 v DC line.
2. Apply the pre-charge resistor of the system for 2 sec.
3. Using a voltmeter, read the voltage across the DC capacitor (this voltage must be equal with 750 v).
4. Read voltage of the line capacitor after 5 minutes (this voltage must be lower than 50 v).

5-1-17- Step change of line voltage test

This test is provided to verify the agreed performance of the converter under sudden line voltage variations.

5-1-17-1- steps to perform the Step change of line voltage test

1. Connect the 12-pulse thyristor rectifier through the 900 KVA transformer to the three-phase line (Use the highest incremental tap).
2. Adjust the rectifier output voltage on 700 v DC.
3. Turn on the ACM.
4. After arriving the output voltage of the ACM to steady-state, change the output voltage of the rectifier to 500 v suddenly.
5. Reverse the previous step, change the voltage from 500 to 700.
6. Examination of DC output voltage changes and AC output voltage changes.