

MANUAL No. PES-A52-001

Document name

E V F P - ϕ 2 0

REVISION : D

ISSUE DATE : 15 May 2013

FILE No. :


Approved by



Reviewed by



Issued by



1.Scope

This standard specifies EVFP (hereinafter referred to as "fuse-link") that is used in the electric vehicle and the hybrid electric vehicle.

2.Classification

The fuse-links shall be classified by their respective rated current as shown in **Table 1**.

Table 1 Classification

Rated current	Part number
60A	2851-0001
70A	2855-0001
80A	2853-0001
100A	2854-0001
125A	2826-0061

The mark* of the Part number is to confirm the latest number on the drawing.

3. Construction

The construction of the fuse-link and the name of each component are shown in **Figure 1**.

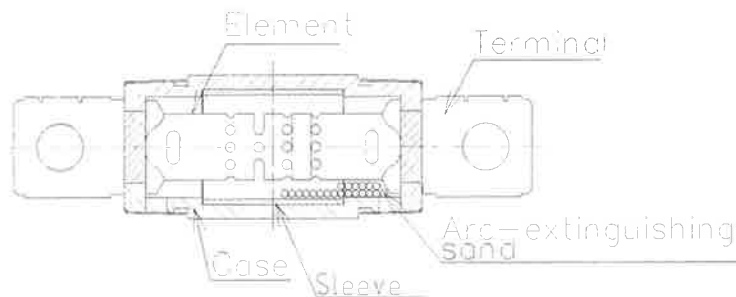


Figure 1 Structural drawing of the fuse-link

3.1 Terminal

electrical conducting part of the fuse-link which is provided to connect a fuse-link with the outside circuit electrically.

3.2 Case

insulation tube exists in most outside to compose a fuse-link.

3.3 Element

active part of the fuse-link, which is provided to melt with occurrence heat of itself and interrupt the current in case of an over current.

3.4 Arc-extinguishing sand

granular sand which is filled to surely extinguish the arc that occurs after the element melted.

3.5 Sleeve

Sleeve is an insulation tube which assembled to secure insulation and prevent leakage of arc after element blow.

4.Attention in the use

- (1) Use the nut or bolt, flat washer and spring washer which are shown by **Figure 2** or corresponding. Give the fusebox guide for prevention of the terminal's twist when the terminals are fastened.
- (2) The tightening torque shall be performed slowly as much as possible within the specified torque range after temporary fastening by bolts on both sides.

- (3) At the tightening as above-mentioned, the difference of elevation between both tightening faces shall be below 0.5 in case that the tightening face in the counter portion does not match with fuse-link.
- (4) Confirm strength of terminal has no problem with fusebox which use practically and the way of tightening.
- (5) Do not use the fuse which are dropped

5.Evaluation items and test items

5.1 Evaluation items

- | | |
|-----------------------------------|--|
| (1) Appearance | (6) Temperature rise |
| (2) Terminal tightening strength | (7) Operating time rating |
| (3) Identification/Ampere marking | (8) Breaking capacity of BAT short-circuit current |
| (4) Temperature characteristics | (9) Insulation resistance |
| (5) Voltage drop | (10) Withstand voltage |

5.2 Test items

- | | |
|---|--------------------------------------|
| (1) Current cycling test | (5) Resistance against corrosion gas |
| (2) Transient current cycling durability test | (6) High temperature/High humidity |
| (3) Vibration test | (7) Temperature/Vibration |
| (4) Resistance against thermal shock | |

Note: Evaluation items and test items may be changed after discussion among the rated sections.

6.Test conditions

The tests of the fuse-link shall be conducted under the following conditions unless otherwise specified.

- (1) Carry out all electrical tests at a temperature of (24 ± 3) °C, a relative humidity (RH) of 45% to 85 %, an atmospheric pressure of 860 hPa to 1060 hPa with still air.
- (2) Mount the fuse-links so that the terminal surface is horizontal using the test module as specified in **Figure 2**. Nuts tighten at the torque as shown in **Table 2**.
- (3) In case the test is conducted while supplying current to the fuse-links, Connections shall be made to the fuse-links as shown in **Figure 2** using not less than 600 mm of copper cable as specified in **Table 3**.
- (4) Carry out the tests at a test voltage of DC (14.0 ± 0.3) V.

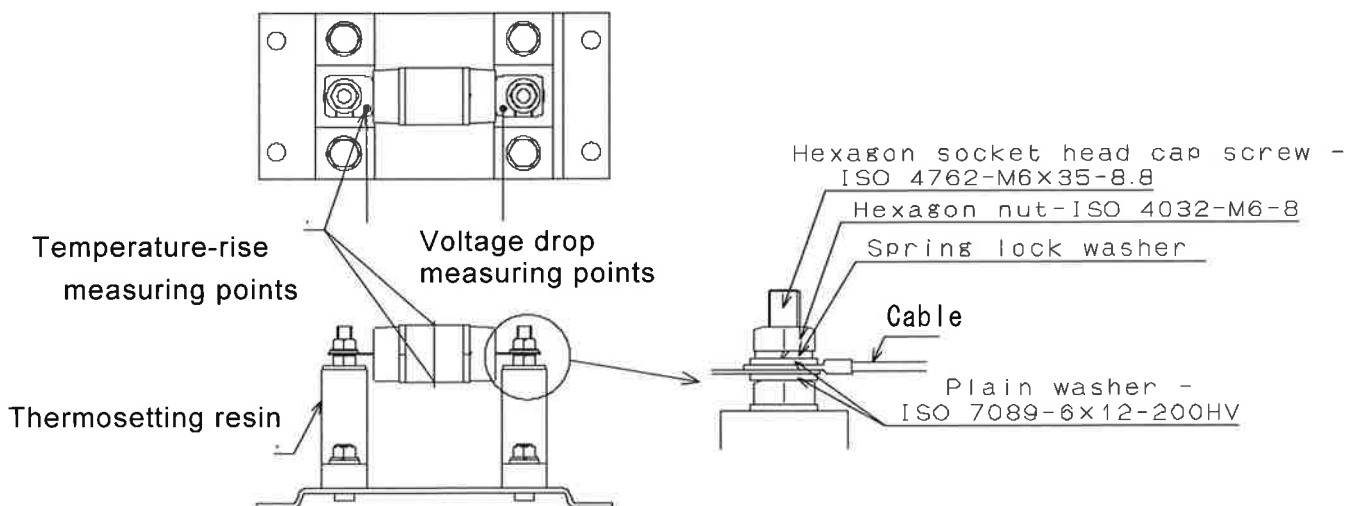


Figure 2 Test module

Table 2 Tightening torque

Nut size	Tightening torque
M6	7.2+/-2.2 N·m

Table 3 Connecting cable size

Rated current	Cable class and size
60A	5sq.mm
70A,80A	8sq.mm
100,125A	15sq.mm

7.Test procedures and sequence

Endurance test

Test sequence, evaluation items and number of samples before/after each test shall be in accordance with **Table 4**.

Table 4 Test sequence

		Initial performance I									
		Initial characteristics			Current cycling test	Transient current cycling durability test	Vibration test	Resistance against thermal shock	Resistance against corrosion gas	High temperature/High humidity	Temperature/Vibration
		I	II	III							
Number of samples (Initial characteristics I show the total of each test.)		48	36	3	10	10	3	10	3	3	9*2
Evaluation items and sequence	(1) Appearance	○			○	○	○	○	○	○	○
	(2) Terminal tightening strength	○									
	(3) Identification/Ampere marking	○			○	○	○	○	○	○	○
	(4) Temperature characteristics		○								
	(5) Voltage drop	○			○	○	○	○	○	○	○
	(6) Temperature rise		○								○
	(7) Operating time rating		○*1								
	(8) Breaking capacity of BAT short-circuit current			○	○	○	○	○	○	○	○
	(9) Insulation resistance		○	○	○	○	○	○	○	○	○
	(10) Withstand voltage	○		○	○	○	○	○	○	○	○

Notes

- 1.Evaluation and test items, number of samples may be changed after discussion among the related sections.
- 2.The sequence shall be as follows: Initial characteristics I →each test→each evaluation items
- 3.*1: Carry out the operating time rating test by n=3 each to the test current (3 points).
- 4.*2: Carry out the temperature/vibration test by n=3 each in three mounting directions.

8. Evaluating methods and test methods

8.1 Evaluating methods

8.1.1 Appearance

Perform with the visual inspection and the touch under the illumination of 300 Lx or more.

8.1.2 Terminal tightening strength

Tighten the terminals in test module as shown in **Figure 2** with the tightening torque as specified in **Table 2** 10 times.

8.1.3 Identification/Ampere marking

Perform with the visual inspection under the illumination of 300 Lx or more.

8.1.4 Temperature characteristics

Subject the fuse-link to the operating time rating test as specified in Sub-clause 7.1.7 in environments at -20 ± 1 , 24 ± 3 , and 80 ± 1 degrees. Calculate a rate of change in fuse current carrying capacity to ambient temperature on the basis of 24 degree for each non-fusing current, each fusing current after 10 seconds and after 2 seconds

8.1.5 Voltage drop

The voltage drop shall be measured between the voltage-drop measuring points as shown in **Figure 2** after the temperature is saturated by supplying the current equal to 50% of the rated current.

8.1.6 Temperature rise

The temperature rise shall be measured at the temperature-rise measuring points as shown in **Figure 2** after supplying the current equal to 50% of the rated current.

8.1.7 Operating time rating

The operating time of the fuse-link shall be measured after supplying the test current.

The test currents of 200,300 and 500% shall be performed in a test voltage of 450VDC.

Table 5 Test current (%)

	Percentage of rated current			
All rated current	110	200	300	500

8.1.8 Breaking capacity of BAT short-circuit current

The breaking current of 2000 A shall be applied at release voltage of DC 450 V Min to the fuse-link.

The test circuit shall be in accordance with **Figure 3**. After test, the following shall be confirmed.

The rise time of the test current shall not exceed 2.5 milliseconds.

- ① Check the appearance during and after interrupt.
- ② Measure a breaking time.
- ③ Measure a switching voltage*1 during interrupt.
- ④ Confirm if there is a current carrying for 180 seconds or more after interrupt.

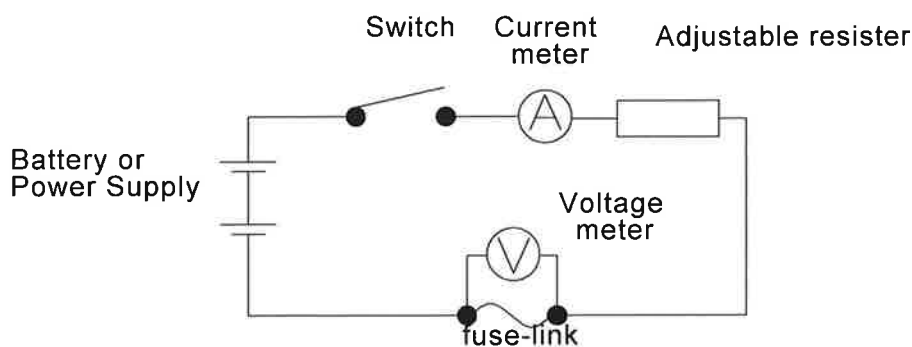


Figure 3 Example of breaking capacity test circuit

8.1.9 Insulation (Open state) resistance

Apply the voltage of DC 500 V to the fuse-links within 5 minutes after the breaking capacity test and measure the insulation resistance between the terminals with insulation resistance tester.

8.1.10 Withstand voltage

Wrap around the case with an aluminum foil as shown in **Figure 4** and apply a commercial frequency of 2500V AC between the terminal and aluminum foil (the case) for 1 minute.

Wrap all around the case with an aluminum foil as avoiding the fixed rings.

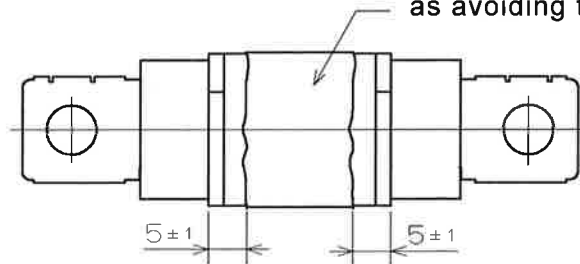


Figure 4 Test method of withstand voltage

8.2 Test methods

8.2.1 Current cycling test

Mount the fuse-links on the test module and supply them with a current in the current cycling pattern as shown in **Figure 5** 20,000 times repeatedly.

The test contents may be changed after discussion among the related sections.

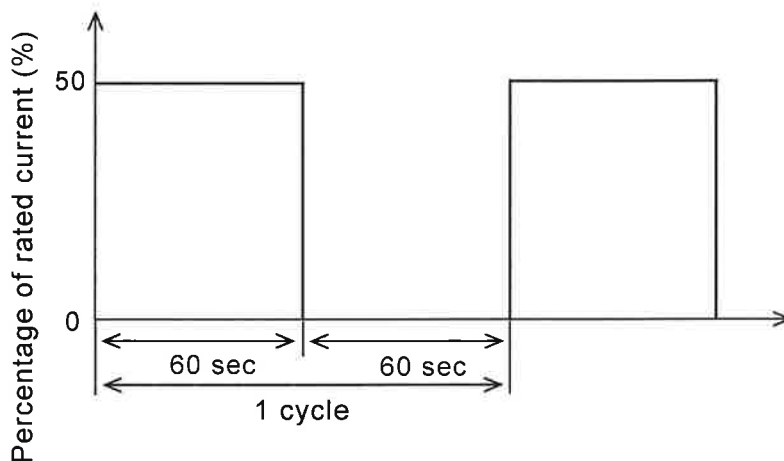


Figure 5 Current cycling

8.2.2 Transient current cycling durability test

Mount the fuse-links on the test module and supply them with a current in the current cycling pattern as shown in **Figure 6** 50,000 times repeatedly.

The test contents may be changed after discussion among the related sections.

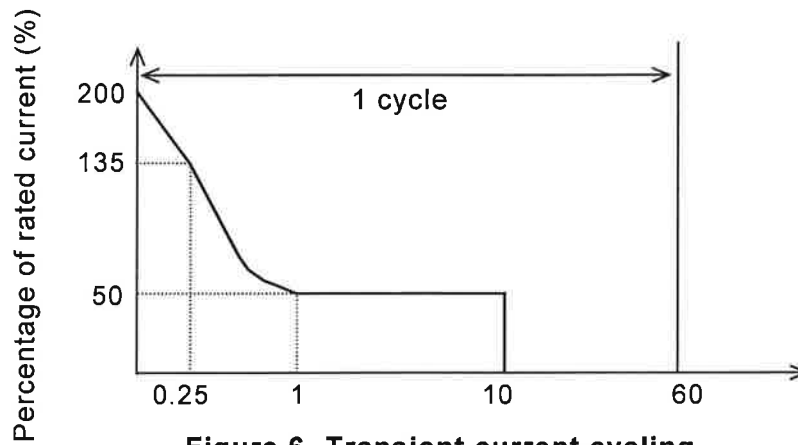


Figure 6 Transient current cycling

8.2.3 Vibration test

Mount the fuse-link on the vibration tester as shown in **Figure 7** and apply a simple harmonic motion to the fuse-links under the conditions as specified in **Table 6**.

The motion shall be applied for 100 hours in each of the three mutually perpendicular directions, two of which shall be horizontal (total 300 hours).

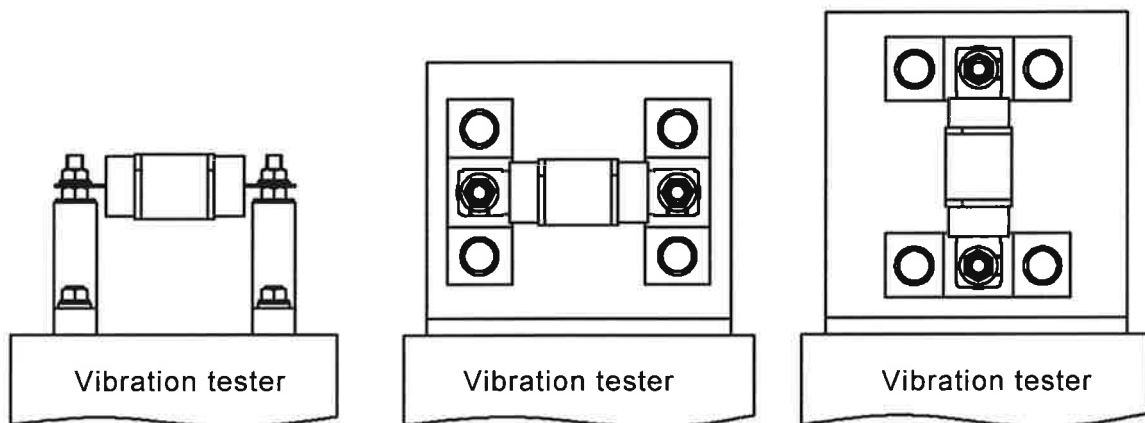


Figure 7 Vibration

Table 6 Test conditions

Items	Conditions
Vibration acceleration	44.1m/s ² (4.5G)
Vibration frequency	20-200 Hz
Sweep time	3 min. (Log sweep)

8.2.4 Resistance against thermal shock

Mount the fuse-link on the test module and subject them to 1,000 thermal shock cycles as shown in **Figure 8**. One cycle consists of:

- (a) 30 min at a temperature of -40 °C,
- (b) 30 min at the temperature of 100 °C.

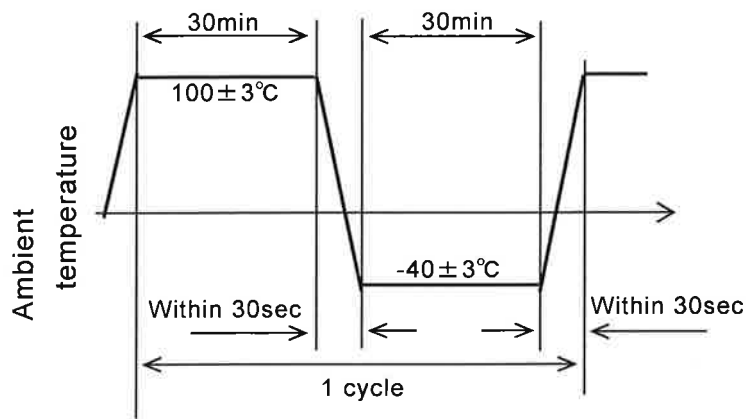


Figure 8 Thermal shock cycle

8.2.5 Resistance against corrosion gas

Mount the fuse-links on the test module and expose them to the environment of sulfur dioxide at 25 ppm density at 75 % relative humidity for 100 hours. Then, expose to the environment of hydrogen gas at 60 % density for 100 hours.

8.2.6 High temperature/high humidity

Mount the fuse-links on the test module and subject them at chamber temperature $(85 \pm 3)^\circ\text{C}$ for 1,000 hours at 93 % to 97 % relative humidity. After that, remove the fuse-links and leave them until it returns to ordinary temperature.

8.2.7 Temperature/vibration

Mount the fuse-links on the vibration tester as shown in **Figure 7** and conduct the test with the vibration and the temperature as specified in **Table 7** in each direction 100 hours (total 300 hours).

Table 7 Temperature/vibration

Items	Conditions
Vibration acceleration	44.1 m/s ² (4.5G) constant
Vibration frequency	20-200Hz
Sweep time	3 min. (Log sweep)
Test temperature	80 ± 3 °C
Current-carrying cycle	Current equal to 50% of the rated current One cycle: 45 min. ON/15 min. OFF

9.Criteria

The criteria shall be in accordance with **Table 8** and **9**.

Table 8 Criteria

No.	Items	Criteria	
1	Appearance	The fuse-links shall be free from defects harmful to use such as flaws, cracks, burr and rust. Also, there shall be no looseness between the element and the case and no leakage of arc-extinguishing sand.	
2	Terminal tightening strength	There shall be no defects such as deformation and breakage that would be impaired functionality.	
3	Identification/Ampere marking	The identification and the ampere marking shall be recognizable clearly.	
4	Temperature characteristics	The ratio of temperature variation in rated current shall exceed -0.18% per 1 degC.	
5	Voltage drop	In the initial characteristics and the measurement after each test, the voltage drop shall not exceed the spec value.	Spec value
			100 mV
6	Temperature rise	In the initial characteristics and the measurement after each test, the temperature rise between the terminal and the case shall not exceed the spec value.	Spec value
			40 degC
7	Operating time Rating	Before the endurance test	Based on Table 9 , No.8-①,④ and No.9
		After the endurance test	
8	Breaking capacity of BAT short-circuit current	① The fuse-link shall be free from defects harmful to use such as fire evolution, breakage and deformation during fusing and after interrupt. ② The breaking time shall exceed 1 seconds. ③ The switching voltage shall exceed 2500 V. ④ The rated voltage shall be maintained during a period. After the test the fuse-links shall meet the requirements specified in No.1, 3, 9 and 10 of the criteria.	
9	Insulation (Open state) resistance	1 Mohm Min	
10	Withstand voltage	There shall be no dielectric breakdown.	

Table 9 Operating time

Test current A	Operating time	
	Min.	Max.
110% of rated current	4h	-
200% of rated current	5s	100s
300% of rated current	0.5 s	15 s
500% of rated current	-	1 s