

Automotive parts – Unscreened low-voltage cables

Introduction

In this revision, this standard specifies the structure and performance of cables that are already in practical use but have not been standardized by **JASO**. In addition, since new test procedures were added to the latest **JASO D 618:2013**, the cables to be tested are selected and performance requirements are added.

1 Scope

This standard specifies low-voltage cables (hereinafter referred to as "cables") used as unscreened single-core low-voltage cables for automobiles, excluding AV (low-voltage cables for automobiles) specified in **JIS C 3406** as well as ALUS, ALSS, and AL (automotive parts – aluminium cables) specified in **JASO D 603**.

In addition, this standard also applies to individual cores comprising a multi-core cable.

The rated voltages for this cable shall be 30 VAC and 60 VDC.

2 Normative reference

The following standards, when referred to in this standard, constitute a part of the specifications of this standard. As required, the most recently updated version of the applicable standard (including addenda) shall be applied.

JASO D 618 Test methods for unscreened low-tension cables for automobiles

JIS C 3102 Annealed copper wires for electrical purposes

JIS C 3152 Tin coated annealed copper wires

3 Cable types, names, symbols, and insulation materials

The cable types, heat resistance classes, names, symbols, insulation materials and structures are as shown in **Table 1**.

4 Performance

Cable performance requirements shall be as specified in **Tables 2** and **3**.

In addition, the performance with different cable types and nominal sizes shall be as specified in **Tables 4** to **8**.

Table 1—Cable types, heat resistance classes, names, symbols, insulation materials and structures

Table 1 Cable types, heat resistance classes, names, symbols, insulation materials and structures						
Type		Heat resistance class (temperature class)	Name	Symbol	Insulation material	Structure
Thick wall		80 °C ^{c)}	Vinyl chloride insulated low-voltage cables for automobiles	AV ^{a)} , HEB or HDEB	Polyvinyl chloride mixture	Table 9
		85 °C ^{d)}	Halogen-free insulated low-voltage cables for automobiles	HF	Halogen-free mixture	Table 10
Thin wall 1		80 °C ^{c)}	Thin wall vinyl chloride insulated low-voltage cables for automobiles	AVS	Polyvinyl chloride mixture	Table 11
Thin wall 2		80 °C ^{c)}	Thin wall vinyl chloride insulated low-voltage cables for automobiles	AVSS, CAVS ^{b)} or CAV ^{b)}	Polyvinyl chloride mixture	Table 12
		85 °C ^{d)}	Very thin wall halogen-free insulated low-voltage cables for automobiles	HFSS or CHFS ^{b)}	Halogen-free mixture	Table 13
Thin wall 3		80 °C ^{c)}	Ultra-thin wall vinyl chloride insulated low-voltage cables for automobiles	CAVUS ^{b)}	Polyvinyl chloride mixture	Table 14
		85 °C ^{d)}	Ultra-thin wall halogen-free insulated low-voltage cables for automobiles	CHFUS ^{b)}	Halogen-free mixture	Table 15
		85 °C ^{d)}	Ultra-thin wall vinyl chloride insulated low-voltage cables for automobiles	CIVUS ^{b)}	Polyvinyl chloride mixture	Table 16
Earth		80 °C ^{c)}	Vinyl chloride-insulated earth bond low-voltage cables for automobiles	EB	Polyvinyl chloride mixture	Table 17
Heat resistance 1	Thick wall	100 °C ^{c)}	Cross-linked vinyl chloride insulated heat resistant low-voltage cables for automobiles	AVX, AVFX or HEBX	Cross-linked PVC mixture	Table 18
		100 °C ^{d)}	Vinyl chloride insulated heat resistant low-voltage cables for automobiles	IVH	Heat resistant PVC mixture	Table 19
	Thin wall 1	100 °C ^{c)}	Thin wall cross-linked PVC insulated heat resistant low-voltage cables for automobiles	AVSX or AVXS	Cross-linked PVC mixture	Table 20
	Thin wall 2	100 °C ^{c)}	Very thin wall cross-linked PVC insulated heat resistant low-voltage cables for automobiles	AVSSX	Cross-linked PVC mixture	Table 21
			Very thin wall PVC insulated heat resistant low-voltage cables for automobiles	AVSSH	Heat resistant PVC mixture	Table 22
		100 °C ^{d)}	Very thin wall vinyl chloride insulated heat resistant low-voltage cables for automobiles	IVSSH	Heat resistant PVC mixture	Table 23
	Earth	100 °C ^{c)}	Cross-linked vinyl chloride insulated heat resistant earth bond low-voltage cables for automobiles	EBX	Cross-linked PVC mixture	Table 24
Heat resistance 2	Thick wall	120 °C ^{c)}	Cross-linked polyethylene insulated heat resistant low-voltage cables for automobiles	AEX	Cross-linked polyethylene mixture	Table 25
	Thin wall 2	120 °C ^{c)}	Very thin wall cross-linked polyethylene insulated heat resistant low-voltage cables for automobiles	AESSX	Cross-linked polyethylene mixture	Table 26
Note ^{a)} The construction that is not specified in JIS C 3406 . ^{b)} CAVS, CAV, CHFS, CAVUS, CHFUS, and CIVUS represent the structure of conductors compressed in a circular shape. ^{c)} Continuous heat resistance temperature at which 100 % insulation elongation can be secured for 10 000 hours. ^{d)} Temperature at which cracking does not occur when a specified bending force is applied to the insulation after it is heated for 3 000 hours						

Table 2—Performance requirements and test procedures for cables

Item		Performance requirement	Test method Based on the following detailed items specified in JASO D 618: 2013.
Structural test		The structure shall conform to the relevant provisions specified in the Structure Table.	6.1
Electrical characteristics	Conductor resistance	Conductor resistance shall be equal to or smaller than the value specified in the Structure Table.	6.2.1
	Withstand voltage	The insulation shall not be fractured in the specified test.	6.2.2
	Spark	The insulation shall not be fractured when the specified voltage is applied.	6.2.3
	Insulation resistance	Minimum volume resistivity shall be $10^9 \Omega \text{ mm}$.	6.2.4
Insulation tensile strength, elongation		Minimum values shall be as specified in Table 4.	6.3
Heat deformation		The insulation shall not be fractured in the withstand voltage test after the specified test.	6.4
Adhesion force		Minimum values shall be as specified in Table 5.	6.5
Low temperature resistance	Winding	The conductor shall not be exposed after the test. The insulation shall not be fractured in the withstand voltage test.	6.6.1
	Impact	The conductor shall not be exposed after the test. The insulation shall not be fractured in the withstand voltage test.	6.6.2
Abrasion resistance	Tape abrasion	Minimum abrasion resistance shall be as specified in Table 6.	6.7.1
	Scrape abrasion	The scrape abrasion resistance shall be equal to or larger than the abrasion cycle specified in Table 7.	6.7.2
Heat resistance 1	Heat resistance 1A	The insulation shall not be fractured in the withstand voltage test after being heated and bended.	6.8.1
	Heat resistance 1B	The insulation shall not be fractured in the withstand voltage test after being heated and bended.	6.8.2
	Heat resistance 1C	The insulation shall neither crack nor melt after being heated.	6.8.3
Heat resistance 2		The insulation shall not be fractured in the withstand voltage test after being heated and wound.	6.9
Heat shrinkage		The shrinkage length of both ends after specified heating process shall be 2 mm or shorter respectively.	6.10
Fluid resistance	Application	The conductor shall not be exposed in the winding test after the specified test. The insulation shall not be fractured in the withstand voltage test.	6.11.2
	Immersion	The conductor shall not be exposed in the winding test after the specified test.	6.11.3
Battery electrolyte test		The conductor shall not be exposed in the winding test after the specified test. The insulation shall not be fractured in the withstand voltage test.	6.11.4
Marking test		The identification mark shall be readable after the specified test.	6.12
Flame resistance test		The burning cable shall self-extinguish within 15 seconds after exposure to naked flame.	6.13
Degree of Cross-linking		The cross-linking degree shall be higher than gel fraction specified in Table 8.	6.14
Note 1 If the application test for fluid compatibility is conducted, both immersion and battery fluid tests are not conducted.			
Note 2 It depends on the agreement between the parties to delivery whether to conduct the application test or immersion test for fluid compatibility.			

Table 3—Performance requirements for cables

Item		Cable type and symbol																	
		Thick wall		Thin wall 1	Thin wall 2		Thin wall 3			Earth	Thick wall		Thin wall 1	Thin wall 2			Earth	Thick wall	Thin wall 2
		AV HEB HDEB	HF	AVS	AVSS CAVS CAV	HFSS CHFS	CAVUS	CHFUS	CIVUS	EB	AVX AVFX HEBX	IVH	AVSX AVXS	AVSSX	AVSSH	IVSSH	EBX	AEX	AESSX
Structural test		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Electrical characteristics	Conductor resistance	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Withstand voltage	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Spark	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Insulation resistance	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Insulation tensile strength, elongation		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Heat deformation		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Adhesion force		○	○	○	○	○	○	○	○	—	○	○	○	○	○	○	—	○	○
Low temperature resistance	Winding	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Impact	○	○	○	○	○	○	○	○	—	○	○	○	○	○	○	—	○	○
Abrasion resistance	Tape abrasion	○	○	○	—	—	—	—	—	—	○	○	○	—	—	—	—	○	—
	Scrape abrasion	—	○	○	○	○	○	○	○	—	—	○	○	○	○	○	—	○	○
Heat resistance 1	Heat resistance 1A	○	—	○	○	—	○	—	—	○	—	—	—	—	—	—	—	—	—
	Heat resistance 1B	—	—	—	—	—	—	—	—	—	○	○	○	○	○	○	○	○	○
	Heat resistance 1C	—	—	—	—	—	—	—	—	—	○	—	○	○	—	—	○	○	○
Heat resistance 2		—	○	—	—	○	—	○	○	—	—	○	—	—	—	○	—	—	—
Heat shrinkage		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Fluid compatibility	Application	—	○	—	—	○	—	○	○	—	—	○	—	—	—	○	—	—	—
	Immersion	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Battery electrolyte test		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Marking test		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Flame resistance test		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Degree of Cross-linking		—	—	—	—	—	—	—	—	—	○	—	○	○	—	—	○	○	○
The items marked with “○” are required performances and those marked with “-” are unnecessary performances. Note 1 If the application test for fluid compatibility is conducted, both immersion and battery fluid tests are not conducted. Note 2 It depends on the agreement between the parties to delivery whether to conduct the application test or immersion test for fluid compatibility.																			

Table 4—Insulation tensile strength, elongation

Cable symbol	Tensile strength MPa	Elongation %
AV, HEB, HDEB, AVS, AVSS, CAVS, CAV, CAVUS, EB, AVX, AVFX, HEBX, AVSX, AVXS, AVSSX, AVSSH or EBX	15.7 or more	125 or more
HF, HFSS, CHFS, CHFUS, CIVUS, IVH or IVSSH	10.3 or more	125 or more
AEX or AESSX	10.3 or more	150 or more

Table 5—Adhesion force

Nominal size	Adhesion force N
0.13~0.22	2 or more
0.3~1.5	5 or more
2	10 or more
3~5	15 or more
Note 1: The nominal size includes the “f” type.	
Note 2: This test is applicable to the nominal sizes of 5 or less.	

Table 6—Minimum abrasion resistance for tape abrasion test

Nominal size	Thick wall and thin wall 1, thick wall and thin wall 1 with heat resistance 1, thick wall with heat resistance 2
	Minimum abrasion resistance mm
0.13	—
0.22	—
0.3, 0.35	300
0.5	400
0.75, 0.85	410
1	420
1.25, 1.5	430
2	450
3	330
5	450
8~12	550
15, 16	635
20	750
30~85	3 430
100	4 570
Note 1: The nominal size includes the “f” type.	
Note 2: “—” means “not applicable.”	

Table 7—Number of abrasion cycles for scrape abrasion test

Nominal size	Number of abrasion cycles Count
0.13~0.22	50 or more
0.3, 0.35	100 or more
0.5	150 or more
0.75, 0.85	160 or more
1	180 or more
1.25	190 or more
1.5	200 or more
2~5	750 or more
Note 1: The nominal size includes the “f” type.	
Note 2: This test is applicable to the nominal sizes of 5 or less.	

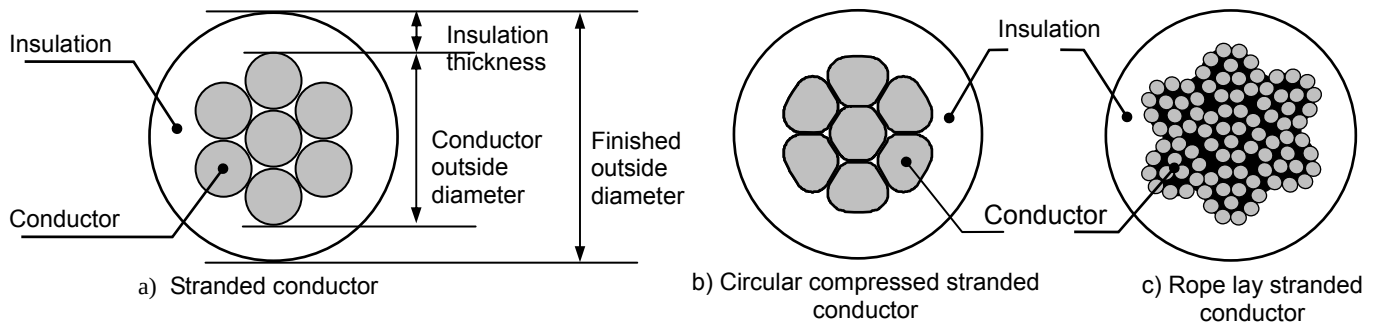
Table 8—Cross-linking degree

Cable symbol	Gel fraction %
AVX, AVFX, HEBX, AVSX, AVXS, AVSSX or EBX	40 or more
AEX or AESSX	50 or more

5 Structure and material

5.1 Structure

The structure of the cable (Refer to **Figure 1**) shall be as shown in appropriate **Tables 9 to 26**.

**Figure 1—Cable structure**

Note The strand construction of rope lay stranded conductor shall show Number of parent strand/ Number of child strand/Strand diameter.

Example “7/9/0.32” means that this is a (parent strand) conductor consisting of seven child strands, each of which is made by combining nine strands with a diameter of 0.32 mm (child strand).

Table 9—Structure of thick wall cables (AV, HEB, or HDEB)

Nominal size	Conductor			Conductor resistance (20 °C) mΩ/m	Insulation thickness		Finished outside dia.	
	Number of strands/dia. of strand Pcs/mm or Pcs/Pcs/mm	Calculated cross sectional area mm ²	Approx. outside dia. mm		Standard mm	Min. mm	Standard mm	Max. mm
2f	37/0.26	1.964	1.8	9.50	0.60	0.48	3.0	3.4
3f	58/0.26	3.079	2.3	6.06	0.70	0.56	3.7	4.0
	61/0.26	3.239	2.4	5.76	0.70	0.56	3.8	4.1
5f	7/9/0.32	5.067	3.1	3.71	0.80	0.64	4.7	5.0
	7/30/0.18	5.344	3.4	3.56	0.80	0.64	5.0	5.3
8f	7/22/0.26	8.176	4.2	2.32	0.90	0.72	6.0	6.3
9f	7/16/0.32	9.008	4.2	2.09	1.00	0.80	6.2	6.5
10f	19/6/0.32	9.168	4.2	2.05	1.00	0.80	6.2	6.5
10	62/0.45	9.861	4.1	1.87	0.90	0.72	5.9	6.2
	63/0.45	10.02	4.5	1.84	1.00	0.80	6.5	6.9
	7/9/0.45	10.02	4.5	1.84	1.00	0.80	6.5	6.9
15f	19/9/0.32	13.75	5.3	1.37	1.10	0.88	7.5	8.0
20f	19/13/0.32	19.86	6.5	0.946	1.10	0.88	8.7	9.3
30f	19/19/0.32	29.03	7.8	0.647	1.40	1.12	10.6	11.3
40f	19/26/0.32	39.73	9.1	0.473	1.40	1.12	11.9	12.6
50f	19/32/0.32	48.90	10.1	0.384	1.60	1.28	13.3	14.1
60f	19/39/0.32	59.59	11.1	0.315	1.60	1.28	14.3	15.1
85f	19/56/0.32	85.57	13.1	0.220	2.00	1.60	17.1	18.1
100f	19/71/0.32	108.5	14.9	0.173	2.00	1.60	18.9	19.9

Note 1: The symbol “f” in the “Nominal size” column means flexible conductor.

Note 2: AV indicates cables with a structure not specified in **JIS C 3406**.

Table 10— Structure of thick wall cables (HF)

Nominal size	Conductor			Conductor resistance (20 °C) mΩ/m	Insulation thickness		Finished outside dia.	
	Number of strands/dia. of strand Pcs/mm or Pcs/Pcs/mm	Calculated cross sectional area mm ²	Approx. outside dia. mm		Standard mm	Min. mm	Standard mm	Max. mm
3	37/0.32	2.976	2.25	6.15	0.70	0.56	3.65	3.90
5	58/0.32	4.665	2.80	3.94	0.80	0.64	4.40	4.70
8	7/14/0.32	7.882	3.95	2.38	0.80	0.64	5.55	5.90
10	7/18/0.32	10.13	4.45	1.82	1.00	0.80	6.45	6.90
12	7/22/0.32	12.39	5.00	1.52	1.00	0.80	7.00	7.40
16	19/11/0.32	16.81	5.85	1.16	1.00	0.80	7.85	8.40
20	19/13/0.32	19.86	6.40	0.946	1.10	0.88	8.60	9.10
30	19/19/0.32	29.03	7.70	0.647	1.30	1.04	10.3	10.9
40	19/26/0.32	39.73	9.00	0.473	1.40	1.12	11.8	12.5
50	19/34/0.32	51.96	10.3	0.368	1.50	1.20	13.3	14.1
60	19/39/0.32	59.59	11.0	0.315	1.50	1.20	14.0	14.9

Table 11— Structure of thin wall "type 1" cables (AVS)

Nominal size	Conductor			Conductor resistance (20 °C) mΩ/m	Insulation thickness		Finished outside dia.	
	Number of strands/dia. of strand Pcs/mm or Pcs/Pcs/mm	Calculated cross sectional area mm ²	Approx. outside dia. mm		Standard mm	Min. mm	Standard mm	Max. mm
0.3	7/0.26	0.371 6	0.8	50.2	0.50	0.32	1.8	1.9
0.3f	15/0.18	0.381 7	0.8	48.9	0.50	0.32	1.8	1.9
0.5f	20/0.18	0.508 7	1.0	36.7	0.50	0.32	2.0	2.1
0.5	7/0.32	0.562 9	1.0	32.7	0.50	0.32	2.0	2.1
0.75f	30/0.18	0.763 0	1.2	24.4	0.50	0.32	2.2	2.3
0.85	16/0.26	0.849 4	1.2	22.0	0.50	0.32	2.2	2.3
	11/0.32	0.884 6	1.2	20.8	0.50	0.32	2.2	2.3
1.25f	50/0.18	1.273	1.5	14.7	0.50	0.32	2.5	2.6
1.25	16/0.32	1.287	1.5	14.3	0.50	0.32	2.5	2.6
2f	37/0.26	1.964	1.9	9.50	0.50	0.32	2.9	3.1
2	26/0.32	2.091	1.9	8.81	0.50	0.32	2.9	3.1
3f	58/0.26	3.079	2.3	6.06	0.60	0.40	3.5	3.7
	61/0.26	3.239	2.3	5.76	0.60	0.40	3.5	3.8
3	41/0.32	3.297	2.4	5.59	0.60	0.40	3.6	3.8
5	65/0.32	5.228	3.0	3.52	0.70	0.48	4.4	4.6
5f	7/30/0.18	5.344	3.4	3.56	0.70	0.48	4.8	5.1
8	50/0.45	7.952	3.7	2.32	0.80	0.64	5.3	5.6
8f	7/22/0.26	8.176	4.0	2.33	0.80	0.64	5.6	5.9

Note 1: The symbol "f" in the "Nominal size" column means flexible conductor.