



Single-Core Stranded ISO Cable

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard specifies the dimension, test methods, and requirements for single-core cables. The standard is based upon and refers to ISO 6722-1.

1.2 Applicability. This standard defines test and validation requirements for single-core cables. It also applies to individual cores in multi-core cables.

1.3 Remarks. Single-core cables are classified by nominal voltage of the system where the cables are used, by the wall dimension of the cable insulation, and by the operating temperature.

1.3.1 Nominal System Voltage Classes.

- 60 V cables intended for use in road vehicle applications where the nominal system voltage is < 60 V_{DC} or 25 V_{AC}.
- 600 V cables intended for use in road vehicle applications where the nominal system voltage is in the range of (60 V_{DC} or 25 V_{AC}) to (600 V_{DC} or 600 V_{AC}) inclusive.

Note: For 600 V applications, the cable shall meet the 600 V performance requirements of ISO 6722-1, regardless wall thickness construction. V_{AC} is Volt Alternating Current and V_{DC} is Volt Direct Current

1.3.2 Temperature Classes. Eight (8) cable classes have been defined in Table 1 to respond to the various temperatures encountered on vehicles.

Table 1: Temperature Class Rating

ISO Temperature Class	Operating Temperature	Equivalent to Temperature Class
A	-40 °C to 85 °C	T1
B	-40 °C to 100 °C	T2
C	-40 °C to 125 °C	T3
D	-40 °C to 150 °C	T4
E	-40 °C to 175 °C	T5
F	-40 °C to 200 °C	T6
G	-40 °C to 225 °C	T7
H	-40 °C to 250 °C	T8

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM B3	ASTM B355	DIN CEN/TS 13388	ISO 1817
ASTM B33	ASTM B452	DIN EN ISO 846	ISO 4926
ASTM B105	ASTM D5374	EN 50149	ISO 6722-1
ASTM B298	ASTM D5423	ISO 34-1	SAE RM-66-06

2.2 GM Standards/Specifications.

GMW3059	GMW3173	GMW3176
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3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities.

3.1.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.1.3 Ovens. Unless otherwise specified, when an oven is required, it shall be a hot air oven. The oven type shall either be a forced air, forced convection, or mechanical convection. The air shall enter the oven in such a way that it flows over the surface of the test pieces and exits near the top of the oven. The oven shall have not less than eight (8) complete air changes and not more than twenty (20) complete air changes per hour at the specified ageing temperature. Reference ASTM D5423 and ASTM D5374 for temperature uniformity and air exchange measurements. See Figure 1.

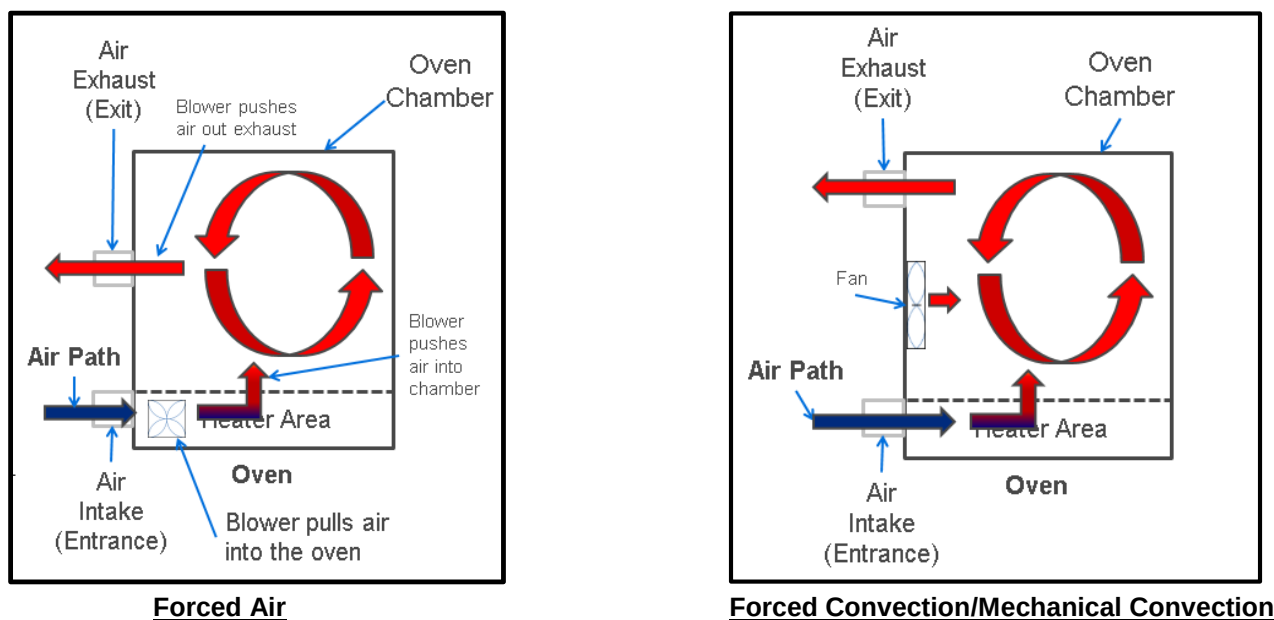


Figure 1: Oven Type

3.1.2 Equipment. See each individual test in 4.3.

3.1.3 Test Vehicle/Test Piece. Number of test samples is specified in each test. The cables to be tested shall be manufactured under full production conditions. No parts out of prototype tools shall be used.

3.1.4 Test Time. See each individual test in 4.3.

3.1.5 Test Required Information. Not applicable.

3.1.6 Personnel/Skills. Not applicable.

3.1.7 Test Required for Certification. The cables shall be submitted to the tests specified in Appendix A, Table A1. Initial qualification tests shall be performed by a certified, independent laboratory, unless otherwise agreed to by the appropriate GM department.

3.2 Preparation. See each individual test in 4.3.

3.3 Conditions.

3.3.1 Environmental Conditions. See ISO 6722-1.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.3.2.1 See ISO 6722-1.

3.4 Instructions. See each individual test in 4.3.

3.5 Data. See 3.7.1.

3.6 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials. Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release. If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Test Results. The results shall be reported in the test report summary. See example in Appendix C. The test report shall include as minimum, the following:

- Name of the supplier.
- Date.
- Supplier Product Designation.
- GM Wire Code Designation.
- Production Location.
- Designation of Compound.
- International Material Data System Identification (IMDS ID) and information, if the International Material Data System (IMDS) datasheet has been approved by the customer.
- Test result and interpretation of test result.

4 Requirements and Procedure

4.1 General.

4.1.1 Safety Concerns. See ISO 6722-1.

4.1.2 Cable Types. See Appendix B (GM Wire Name Code Designation) on defining the cable types, based on construction, conductor, temperature class, wall thickness, and insulation materials.

4.2 Material.

4.2.1 Conductor. The conductor shall consist of plain, coated copper or copper alloy strands as shown in Table 2.

Table 2: Conductor Specification

Specification	Conductor
ASTM B3	Soft or annealed copper wire
ASTM B33	Tinned soft or annealed copper wire
ASTM B298	Silver coated soft or annealed copper wire
ASTM B355	Nickel-coated soft or annealed copper wire
EN 50149 DIN CEN/TS 13388	Copper Magnesium Alloy (CuMg02)
DIN CEN/TS 13388	Copper Silver Alloy (CuAg01)
DIN CEN/TS 13388	Copper Tin Alloy (CuSn03)
ASTM B452	Copper Clad Steel (CCS)
ASTM B105	Copper Alloy

4.2.1.1 Conductor sizes $> 0.5 \text{ mm}^2$ shall consist of soft annealed copper or annealed compressed/compact wires. Conductor sizes $\leq 0.5 \text{ mm}^2$ shall consist of soft annealed copper, soft annealed compressed/compact copper, or a copper alloy. Hard drawn copper shall not be used. The specifications for conductors shall be completed by material specifications. Elongation requirements shall be established by agreement between customer and supplier. When a copper alloy is used, the type of alloy and resistance requirement shall be established by agreement between customer and supplier. Copper clad steel (CCS) wire is used in unique applications (i.e., signal circuits), due to its low conductivity. Therefore, the usage of copper clad steel wire must be approved by General Motors Power and Signal Distribution System (PSDS) wiring group.

4.2.2 Insulation. Conductors shall be insulated with material complying with the requirements in this standard. Insulation shall be smooth and free from cracks, pitting and other defects visible to the naked eye.

4.2.3 Colors. A list of the ten (10) colors to be used, including stripe combinations and abbreviations of the colors, are specified in GMW3176.

4.2.4 Marking. The usage of marking is to be established between customer and supplier.

4.3 Test and Performance Requirements.

4.3.1 Outside Cable Diameter. The measurement is carried out according to ISO 6722-1. All measurements shall be within the limits of the appropriate maximum and minimum outside cable diameter in Table 4.

4.3.2 Insulation Thickness. The measurement is carried out according to ISO 6722-1. The insulation thickness shall be in accordance with the required insulation thickness in Table 4.

4.3.3 Conductor Diameter. The measurement is carried out according to ISO 6722-1. All measurements shall be within the limits of the appropriate maximum outside conductor diameter in Table 4.

4.3.4 Diameter of Strand and Number of Strands. The measurement is carried out according to ISO 6722-1. The strand diameter and number of strands shall be in accordance with the required values given in Table 3.

4.3.5 Conductor Resistance. The measurement is carried out according to ISO 6722-1. The corrected value shall not exceed the appropriate maximum and minimum resistance specified in Table 5.

Table 3: Conductor Stranding and Dimensions Note 1, Note 2

Conductor Size (mm ²)	Structure A (Symmetrical)		Structure B (Asymmetrical)		Structure C (High Strand)	
	Number of Strands (minimum)	Strand Diameter maximum (mm)	Number of Strands (minimum)	Strand Diameter maximum (mm)	Number of Strands (minimum)	Strand Diameter maximum (mm)
0.13	7	0.16	-	-	-	-
0.22	7	0.21	-	-	-	-
0.35	7	0.27	12	0.21	19	0.16
0.5	19	0.19	16	0.21	37	0.14
0.75	19	0.24	24	0.21	38	0.16
1	19	0.27	32	0.21	54	0.16
1.5	19	0.33	30	0.26	76	0.16
2	19	0.38	28	0.31	105	0.16
2.5	37	0.28	50	0.26	140	0.16
3	37	0.34	44	0.31	160	0.16
4	37	0.38	56	0.31	224	0.16
5	37	0.43	65	0.33	250	0.16
6	37	0.45	84	0.31	320	0.16
8	98	0.33	62	0.41	240	0.21
10	63	0.46	80	0.41	320	0.21
12	154	0.33	96	0.41	380	0.21
16	105	0.46	126	0.41	512	0.21
20	247	0.33	152	0.41	610	0.21
25	154	0.46	196	0.41	790	0.21
30	361	0.33	224	0.41	900	0.21
35	551	0.30	276	0.41	1070	0.21
40	494	0.33	308	0.41	1200	0.21
50	798	0.30	396	0.41	1600	0.21
60	741	0.33	296	0.51	1200	0.26
70	1140	0.30	360	0.51	1427	0.26
95	836	0.40	475	0.51	1936	0.26
120	1064	0.40	608	0.51	2450	0.26

Note 1: For Structure A and B, cross-sections consisting of more than 80 strands, a minor deviation in number of strands ($\pm 3\%$) is acceptable, provided that the electrical resistance and the maximum strand diameter still are met. Other stranding configurations may be acceptable, if approved by GM Engineering.

Note 2: For sizes 0.13 mm² to 2.0 mm², all new programs to use Type A construction. For sizes 2.5 mm² or larger, either Type A or Type B can be used. Type "C" is for "High Flex" applications, where high flexibility and flexlife durability is desired.

Table 4: Dimensions

ISO Conductor		Thin Wall				Thick Wall				Ultra-Thin Wall													
		Outside Diameter		Insulation Thickness		Outside Diameter		Insulation Thickness		Outside Diameter		Insulation Thickness											
Size mm²	mm Max.	Min.	Max.	Nom.	Min.	Min.	Max.	Nom.	Min.	Min.	Max.	Nom.	Min.										
0.13	0.55	0.95	1.05	0.25	0.20	N/A				0.85	0.95	0.20	0.16										
0.22	0.70	1.10	1.20							0.95	1.05												
0.35	0.90	1.20	1.40							1.10	1.20												
0.50	1.10	1.40	1.60	0.28	0.22	2.00	2.30	0.60	0.48	1.30	1.40			0.25	0.20								
0.75	1.30	1.70	1.90	0.30	0.24	2.20	2.50			1.45	1.60												
1.00	1.50	1.90	2.10			2.40	2.70			1.55	1.75												
1.50	1.80	2.20	2.40			2.70	3.00			1.90	2.10												
2.00	2.00	2.50	2.80	0.35	0.28	3.00	3.30	0.70	0.56	2.20	2.40	N/A											
2.50	2.20	2.70	3.00			3.30	3.60			2.50	2.70												
3.00	2.40	3.10	3.40	0.40	0.32	3.80	4.10	0.80	0.64	N/A													
4.00	2.80	3.40	3.70			4.00	4.40																
5.00	3.10	3.90	4.20			4.50	4.90																
6.00	3.40	4.00	4.30			4.60	5.00																
8.00	4.30	4.60	5.00			5.00	5.90																
10.00	4.50	5.30	6.00	0.60	0.48	5.90	6.50	1.00	0.80					N/A									
12.00	5.40	5.80	6.50			6.60	7.40																
16.00	6.30	6.40	7.20	0.65	0.52	7.70	8.30	1.10	0.88								N/A						
20.00	6.90	7.00	7.80			8.10	9.10																
25.00	7.80	7.90	8.70			9.40	10.40	1.30	1.04														
30.00	8.30	8.70	9.60	0.80	0.64	9.70	10.90																
35.00	9.00	9.40	10.40			9.60	11.60	1.40	1.12														
40.00	9.60	10.00	11.10	0.90	0.71	11.20	12.40																
50.00	10.50	11.00	12.20			11.50	13.50	1.50	1.20														
60.00	11.60	12.00	13.30	1.00	0.80	13.40	14.60																
70.00	12.50	13.00	14.40			13.50	15.50																
95.00	14.80	15.30	16.70	1.10	0.90	16.00	18.00	1.60	1.28											N/A			
120.00	16.50	N/A				17.70	19.70																

Note:

Max. = Maximum

Min. = Minimum

N/A = Not applicable

Nom. = Nominal