

ENGINEERING SPECIFICATION NO.

M3101

TITLE **CABLE, LOW TENSION, CROSS LINKED POLYETHYLENE, INSULATED, EXTRA FLEXIBLE**

1. **GENERAL**

This specification covers a cross linked polyethylene insulated cable for use in low tension automotive wiring circuits.

2. **MANUFACTURE**

2.1 **Conductors**: The conductors shall be bare, annealed, copper wire, bunched stranded in accordance with SAE J-1128.

2.1.1 See Para. 4 of this specification for sizes and dimensions.

2.1.2 **Splices** - Splices are permitted in the individual strands and the members provided that they do not increase the diameter, decrease the break strength by more than 20%, increase the resistance of the conductor or have a length greater than 7mm. Splices are not permitted in the conductor as a whole.

2.2 **Insulation**: - The cross linked polyethylene insulation, homogeneous in character, shall be placed concentrically about the conductors. Insulation shall adhere closely to but strip readily from the conductors leaving them reasonably clean and in suitable condition for soldering, (see Para. 4 of this specification for dimensions.) The material shall be M2914 (electron beam cross linked) or insulation by approval through Cable Engineering.

3. **PROPERTIES**

3.1 **Properties Of Conductor**:

3.1.1 The conductors shall meet all requirements of SAE J-1128 with wire size and stranding as shown in Para. 4 of this specification.

3.1.2 **Before Stranding** - The wire must meet the requirements of ASTM B-3 for tensile strength, elongation, resistivity, dimensions and finish.

LW/ae

Date	Change Notice	Change
08/02/07	293905	Add New Colors
01/24/08	297455	Add New Colors

3.2 Properties of the Insulation

3.2.1 Physical properties of the insulation as removed from the cable.

	<u>Test Method</u>	<u>Value</u>
3.2.1.1 Tensile Strength		
3.2.1.1.1 Original MPa (psi)	ASTM D-412	10.34 (1500) min.
3.2.1.1.2 Heat Age (%)		Min. 80% of Original Tested Value
3.2.1.2 % Elongation At Break	ASTM D-412	
3.2.1.2.1 Original (%)		150% min.
3.2.1.2.2 Heat Aged (%)	ASTM D-794	Min. 50% of Original Tested Value

3.2.2 Testing

3.2.2.1 Tensile strength and elongation tests. The test will be conducted with a cross-head speed of 500mm (20") per minute.

3.2.2.2 All tensile and elongation test samples will be conditioned at 23°C for at least 16 hours prior to testing.

3.2.2.3 Heat aging consists of conditioning test specimens in an oven for 7 days (168 hrs.) at 165°C (core removed).

3.2.3 Pinch and abrasion shall meet requirements of SAE J-1128 type GPT. All other properties shall meet requirements of SAE J-1128 type SXL.

3.3 Color And Print

The color of the cable shall be as specified by code number on the purchase order (see the code sheet in this specification). The colors shall target to the recommended color information referenced in SAE J-1128.

3.3.2 The cable shall be printed with a permanent identification marking approximately every 320mm along the entire length of the cable.* The size of the marking shall be appropriate to the diameter of the cable so that the marking is easily distinguishable and legible. The shape of the marking shall be approved by Delphi Automotive Systems. The color of the marking shall be determined by the base color of the cable:

<u>INSULATION COLOR</u>	<u>MARKING COLOR</u>
BLACK	WHITE OR BLACK
BLUE DK	BLACK
BLUE LT	BLACK
BROWN	BLACK
GRAY	BLACK
GREEN DK	BLACK
GREEN LT	BLACK
ORANGE	BLACK
PINK	BLACK
PURPLE	BLACK
RED	BLACK
TAN	BLACK
WHITE	BLACK
YELLOW	BLACK

*Delphi Packard cable manufacturing plants are not required to print identification marks.

3.3.2.1 Delphi Automotive will assign each XLPE cable vendor a unique identification code to verify the manufacturer of the cable.

3.3.3 Cables requiring stripes shall be extruded with two continuous solid stripes of the color specified. The stripes shall be on opposite sides of the cable. The stripe color shall completely mask the base cable color. See Table II for stripe width dimensions.

3.4 Cable Performance Requirements

The finished cable shall meet the performance requirements of SAE J-1128, Type TXL, except the following:

3.4.1 Dimensions. - Shall meet the requirements of Para. 4 (EST-459).

3.4.2 Heat Age Test Temperature - Shall meet the requirements of 3.2.2.3

3.4.3 Strip Force – Shall be tested per EST-455.

3.4.4 Resistance – Shall be tested per EST-930.

3.5 No separators are permitted.

- 3.6 Insulation Strip Force - The strip force required to remove 50.8mm (2 in.) of insulation from the conductor (25.4mm (1 in) for .8mm² cable) shall be in accordance with the following chart. Insulation shall not bond to the conductors. Pull the conductor from the insulation at a rate of 50mm \pm 2.5mm per minute.

Wire Size		AVERAGE STRIP FORCE (5 READINGS)			
AWG	(mm ²)	Min.		Max.	
		Lb.	(N)	Lb.	(N)
18	0.8	9.0	40	18.0	80
16	1	4.5	20	19.1	85
14	2	4.5	20	21.4	95
12	3	4.5	20	23.6	105
10	5	4.5	20	27.0	120
8	8	4.5	20	30.4	135
6	13	4.5	20	33.7	150
4	19	4.5	20	37.1	165

- 3.7 Shrinkage - Cut a cable in the middle of a section at least 1.0 m (3 ft.) in length and immediately check for insulation shrinkage. No shrinkage is allowed.
- 3.8 All finished cable shall be cadmium free.

4. DIMENSIONS

Conductor and finished cable dimensions are shown in Table I and Table II. Check dimension per EST-459.

Table I - Conductor Dimensions

<u>Wire Size</u> (mm ²)		<u>No. of Members</u>	<u>No. of Strands/ Member</u>	<u>Minimum Average Strand Dia. (mm)</u>	<u>Length of Lay (mm)</u>		<u>Nom. Dia. of Stranded Cond (Ref.) (mm)</u>	<u>Max. Resistance (Ref.) mOhms/Meter @ 20°C</u>
<u>AWG</u>	<u>Min</u>				<u>Max</u>			
0.8	18	7	15	.096	10	50*	1.26	24.6
1	16	7	15	.117	25	50*	1.54	16.4
2	14							
3	12	1	65	.239	25	50	2.20	6.14
5	10	1	105	.254	25	50	2.98	3.37
8	8	19	7	.277	40	90*	4.19	2.15
13	6	19	7	.341	50	90*	5.03	1.48

* Maximum Lay For Individual Members = 25mm (1 in.)

Table II - Finished Cable Dimensions

<u>Wire Size</u> (mm ²)		<u>Stripe Width (mm) (Ref.)</u>		<u>Min. Wall Thickness (mm)</u>		<u>Finished Cable O.D. (mm)</u>
<u>AWG</u>	<u>Min</u>	<u>Max</u>	<u>Individual</u>	<u>Average</u>		
0.8	18	.4	1.2	.41	.46	2.34
1	16	.4	1.1	.36	.41	2.56
2	14					
3	12	.6	1.9	.50	.57	3.73
5	10	.8	2.4	.50	.57	4.57
8	8	.9	2.7	.40	.44	5.29
13	6	1.2	3.7	.50	.57	7.15

Notes: #1 - For wire sizes 0.5mm² through 5mm², the tolerance on the finished O.D. shall be $\pm .08\text{mm}$ (.003 in.) for the average of 5 readings over a 1m (3 ft.) length. The tolerance for an individual measurement shall be $\pm .13\text{mm}$ (.005 in.).

#2 - For wire sizes 8mm² through 19mm², the tolerance on the finished O.D. shall be $\pm .13\text{mm}$ (.005 in.) for the average of 5 readings over a 1m (3 ft) length. The tolerance for an individual measurement shall be $\pm .18\text{mm}$ (.007 in.).

5. PACKAGING

- 5.1 Unless otherwise specified on the purchase order, wire sizes 0.5mm² (20 Ga) through 8.0mm² (8 Ga) shall be supplied in barrels.
- 5.2 Slipper compound may be used as required to facilitate barrel packing and/or reduce tangles. Use Gem Gravure Type SC slipper compound (regular #5000) mixed with an equal part of water, or other slipper compound approved by Delphi Automotive Systems. The compound should be dripped onto an applicator pad to evenly coat the cable insulation prior to being barrel packed.
- 5.3 Lengths/Standard Package

Wire Size (mm ²)	Maximum Number of Lengths/Package						
	0.5	0.8	1	2	3	5	8
Min. Footage							
1,000	1	1	1	1	1	1	1
2,500	2	2	2	2	2	2	2
5,000	2	2	2	2	2	2	2
7,500	2	2	2	2	2	2	3
10,000	2	2	2	2	2	3	4
15,000	2	2	2	2	3	4	
20,000	2	2	2	3	4		
30,000	2	2	3	4			
36,000	2	3	4				
50,000	3	4					

6. MARKING

Each barrel shall be marked as shown:

Name of Manufacturer
 Net Weight of Material - Footage
 Lot Number
 Purchase Order Number*
 M3101 - Code Number

*Not required for cable manufactured by Delphi.

7. FACTORY ACCEPTANCE

Material as supplied under this specification shall comply with processing and physical requirements so required by Delphi Automotive Systems.

8. CERTIFICATION AND TESTING

Delphi Automotive may request at any time and receive from the supplier samples of the insulating compound for testing at Delphi Automotive. Test results pertinent to this cable which demonstrate conformance to this specification will be subject to recall on demand by Delphi Automotive Systems.

9. IN-PROCESS TEST

All cable shall be spark tested at 3000 volts at the final cable handling process prior to the cable being packaged for shipment. No package shall have average continuous lengths of less than 3048m (10,000 ft.). All spark failures shall be removed from barrels and the leading end of each length of cable shall be identified with an easily distinguishable tape flag at least 12.7mm (0.5 in.) in length. The flagged end may then be dropped into the barrel. All reels which contain spark failures shall be rewound and the spark failure marked by removing approximately 150mm (6 in.) of insulation and applying a red tape marker. Twisted cable splices or knots in the cable are unacceptable.

10. REJECTION

All material which does not conform to the above requirements shall be rejected.

11. MATERIAL CHANGE

The supplier must notify the Cable Engineer, Delphi Automotive, in writing and obtain written approval prior to making any change in the basic formulation, composition and/or manufacturing process of this material originally approved and supplied under this specification.

12. RESTRICTED AND REPORTABLE MATERIALS:

All materials supplied to this specification must comply with Delphi Automotive Systems specification 10949001 "Substances of Concern and Recycled Content".

CODE SHEET

Size Replaces	*0.8mm ² <u>18 Ga.</u>	*1.0mm ² <u>16 Ga.</u>	3mm ² <u>12 Ga.</u>	5mm ² <u>10 Ga.</u>	*8mm ² <u>8 Ga.</u>	*13mm ² <u>6 Ga.</u>
<u>Solid Colors</u>						
Black	201	301	501	601	701	801
Blue Dk	202	302	502	602	702	802
Blue Lt	203	303	503	603	703	803
Brown	204	304	504	604	704	804
Gray	205	305	505	605	705	805
Green Dk	206	306	506	606	706	806
Green Lt	207	307	507	607	707	807
Orange	209	309	509	609	709	809
Pink	210	310	510	610	710	810
Purple	211	311	511	611	711	811
Red	212	312	512	612	712	812
Tan	213	313	513	613	713	813
White	208	308	508	608	708	808
Yellow	214	314	514	614	714	814

Double Striped Cable

<u>Color</u>	<u>Stripe</u>						
Black	Gray	C02	D02	F02	G02	H02	J02
Black	Red	220	320	520	620	720	820
Black	Yellow	223	323	523	623	723	823
Black	Lt Green	219	319	519	619	719	819
Blue Lt	White	225	325	525	625	725	825
Brown	White	228	328	528	628	728	828
Gray	Purple	C46	D46	F46	G46	H46	J46
Gray	Tan	C97	D97	F97	G97	H97	J97
Gray	Yellow	263	363	563	663	763	863
Gray	White	246	346	546	646	746	846
Green Lt.	Black	231	331	531	631	731	831
Green Lt	Purple	C23	D23	F23	G23	H23	J23
Pink	Black	235	335	535	635	735	835
Purple	Gray	C49	D49	F49	G49	H49	J49
Purple	White	237	337	537	637	737	837
Red	Black	238	338	538	638	738	838
Tan	Blue Dk	C64	D64	F64	G64	H64	J64
Tan	Yellow	250	350	550	650	750	850
White	Black	233	333	533	633	733	833
White	Orange	281	381	581	681	781	881
Yellow	Gray	261	361	561	661	761	861

*CV production is not recommended.