

DELPHI

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F-3548SPECIAL

ENGINEERING SPECIFICATION NO.**M5630**

TITLE **THIN WALL –CABLE, AUTOMOTIVE, LOW TENSION, CROSS LINKED POLYETHYLENE, INSULATED 600V**

1. **GENERAL**

This specification covers a cross linked polyethylene insulated cable for use in automotive wiring circuits up to 600V.

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

2.2 **Insulation:** The cross linked polyethylene insulation, homogeneous in character, shall be placed concentrically within SAE tolerance 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 M2172 (chemically cross linked), 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.

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

LW/em

Date	Change Notice	Change
3/24/09	307532	Add gage sizes; Correct Clerical Error
11/23/10	CN100762	Add New Colors

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).

3.3 Color And Print

- 3.3.1 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. 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 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 and SAE J1654, 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.

*Dielectric Strength, insulation resistance, pinch and abrasion shall meet the highest requirement listed in the SAE specs for the cable gage and type.

- 3.5 No separators are permitted.
- 3.6 Insulation Strip Force - The strip force required to remove 50.8mm (2") of insulation from the conductor shall be in accordance with the following chart. Insulation shall not bond to conductors when stripped. Pull the conductor from the insulation at a rate of 50mm \pm 2.5mm per minute.

<u>AWG</u>	<u>WIRE SIZE</u> (mm ²)	<u>STRIP FORCE (5 READINGS)</u> <u>SINGLE MINIMUM VALUE</u>	
		<u>LB.</u>	<u>(N)</u>
22 - 18	.35 - .80	2.2	10
16 - 10	1.0 - 5.0	4.5	20

- 3.7 Shrinkage - Cut a cable in the middle of a section at least 1.0m (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 dimensions per EST-459.

Table I – Conductor Dimensions

Wire Size		No. of Strands	Nom. Size of Strand*		Min. Avg. Strand Dia. (mm)	Length of Lay* (mm) LH		Nom. Dia. Of Stranded Cond.* (mm)	Max. Resistance* (mΩ/m)@20°C
<u>AWG</u>	<u>(mm²)</u>		<u>AWG</u>	<u>(mm)</u>		<u>Min.</u>	<u>Max.</u>		
22	0.35	7	30	.25	.243	15	55	0.73	53.2
20	0.5	7	28	.31	.304	18	55	0.92	31.5
18	0.8	19	32	.23	.226	18	55	1.14	22.7
16	1.0	19	29	.28	.274	30	55	1.38	15.7
14	2.0	19	27	.36	.353	34	55	1.77	9.29
12	3.0	19	25	.45	.443	34	55	2.23	5.90
10	5.0	19	23	.57	.559	34	55	2.81	3.72

*Reference dimension

Table II – Finished Cable Dimensions

Wire Size		Stripe Width (mm)		Min. Wall Thickness (mm)		Finished Cable O.D. (mm)
<u>AWG</u>	<u>(mm²)</u>	<u>Min.</u>	<u>Max.</u>	<u>Individual</u>	<u>Average</u>	
22	0.35	.2	.8	.28	.32	1.55
20	0.5	.3	.9	.28	.32	1.72
18	0.8	.3	1.0	.28	.32	1.94
16	1.0	.4	1.1	.28	.32	2.17
14	2.0	.4	1.3	.28	.32	2.58
12	3.0	.5	1.6	.32	.36	3.12
10	5.0	.6	1.9	.35	.40	3.8

Note: The tolerance on the finished cable O.D. shall be \pm .08mm for the average of 5 readings over 1 m (3 ft.) length. The tolerance for an individual measurement shall be \pm .13mm.

5. PACKAGING:

- 5.1 Unless otherwise specified on the purchase order, all cable 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 compounds approved by Delphi. The compound should be dripped onto an applicator pad to evenly coat the cable insulation prior to being barrel packed.

6. MARKING: Each cable pack shall be identified by a suitable identification ticket secured to the leading end of the cable and attached to the inside of the barrel with the following information:

- Name of Manufacturer
- Net Weight of Material - Footage
- Lot Number
- Purchase Order Number*
- M5630 and 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.**8. CERTIFICATION AND TESTING:** Delphi may request at any time and receive from the supplier samples of the insulating compound for testing at Delphi. Test results pertinent to this cable which demonstrate conformance to this specification are subject to recall on demand by Delphi.**9. IN-PROCESS TEST:** All cable .5mm² and smaller shall be spark tested at 5000 volts, all cable .8mm² and larger shall be tested at 6000 volts at the final cable handling process prior to the cable being packaged for shipment. All spark failures shall be removed. No package shall have average continuous lengths of less than 3048m (10,000 ft.). 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. 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 at Delphi, 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 Corporation specification 10949001 "Substances of Concern and Recycled Content".

13. **CODE SHEET**

NOTE: Each reel of finished cable shall be identified with the Delphi part number and the M5630 code number as specified in Para. 6, Marking.

SOLID COLOR CABLE

	WIRE SIZE (mm ²)	<u>0.35</u>	<u>0.50</u>	<u>0.80</u>	<u>1.00</u>	<u>2.00</u>	<u>3.00</u>	<u>5.00</u>
		<u>(22)</u>	<u>(20)</u>	<u>(18)</u>	<u>(16)</u>	<u>(14)</u>	<u>(12)</u>	<u>(10)</u>
BLACK		001	101	201	301	401	501	601
BLUE DK		002	102	202	302	402	502	602
BLUE LT		003	103	203	303	403	503	603
BROWN		004	104	204	304	404	504	604
GRAY		005	105	205	305	405	505	605
GREEN DK		006	106	206	306	406	506	606
GREEN LT		007	107	207	307	407	507	607
ORANGE		009	109	209	309	409	509	609
PINK		010	110	210	310	410	510	610
PURPLE		011	111	211	311	411	511	611
RED		012	112	212	312	412	512	612
TAN		013	113	213	313	413	513	613
WHITE		008	108	208	308	408	508	608
YELLOW		014	114	214	314	414	514	614

STRIPED CABLE

<u>COLOR</u>	<u>STRIPE</u>							
BLACK	BLUE DK	A02	B02	C02	D02	E02	F02	G02
BLACK	BLUE LT	048	148	248	348	448	548	648
BLACK	BROWN	A33	B33	C33	D33	E33	F33	G33
BLACK	GRAY	A60	B60	C60	D60	E60	F60	G60
BLACK	GREEN DK	A01	B01	C01	D01	E01	F01	G01
BLACK	GREEN LT	015	115	215	315	415	515	615
BLACK	ORANGE	018	118	218	318	418	518	618
BLACK	PINK	016	116	216	316	416	516	616
BLACK	PURPLE	053	153	253	353	453	553	653
BLACK	RED	017	117	217	317	417	517	617
BLACK	TAN	060	160	260	360	460	560	660
BLACK	WHITE	019	119	219	319	419	519	619
BLACK	YELLOW	020	120	220	320	420	520	620
GRAY	BLACK	049	149	249	349	449	549	649
GREEN LT	BLACK	031	131	231	331	431	531	631
ORANGE	BLACK	034	134	234	334	434	534	634
ORANGE	GRN DK	A29	B29	C29	D29	E29	F29	G29
ORANGE	WHITE	A20	B20	C20	D20	E20	F20	G20
PINK	BLACK	035	135	235	335	435	535	635
WHITE	BLACK	033	133	233	333	433	533	633
WHITE	BLUE DARK	A11	B11	C11	D11	E11	F11	G11
WHITE	GRAY	A41	B41	C41	D41	E41	F41	G41
WHITE	GREEN DARK	059	159	259	359	459	559	659
WHITE	ORANGE	081	181	281	381	481	581	681
WHITE	PURPLE	070	170	270	370	470	570	670
WHITE	RED	082	182	282	382	4852	582	682
WHITE	YELLOW	A27	B27	C27	D27	E27	F27	G27
YELLOW	BLACK	043	143	243	343	443	543	643