

# Finolex



An IS / ISO 9001 Company

**LT CROSS-LINKED POLYETHYLENE (XLPE) POWER CABLES**



## LT 'FINVUL-X' CROSS-LINKED POLYETHYLENE (XLPE) INSULATED POWER CABLES

Finolex has developed a special grade XLPE compound 'FINVUL-X' to be used as the insulating material suitable for LT (upto 1100 volts) applications. This is a thermoset type of polymer enriched with crosslinking agent. This is extruded over the conductor using modern extruders and is thoroughly crosslinked under controlled conditions. This XLPE insulation overcomes the drawbacks of PVC, hitherto extensively used as an insulating material, without losing any of PVC's desirable properties.

Following are the advantages of 'FINVUL-X' insulated cables over that of PVC Insulated cables:

- **Higher Current Rating :**

Withstands continuous conductor temperature of 90°C, whereas PVC withstands only 70°C, which means higher current carrying capacity.

- **Higher Overload Capacity :**

'FINVUL-X' cables can operate even at 130°C, during emergency, unlike PVC Cables which cannot operate beyond 120°C. Thus in an emergency, the entire system need not go out of commission if some of the cables fail, because the other cables in parallel can carry a higher load.

- **Higher Short Circuit Rating :**

Can withstand conductor temperatures of upto 250°C during a short circuit – PVC cannot withstand more than 160°C.

- **Lighter in Weight, Smaller Bending Radius :**

Lighter weight, smaller bending radius than PVC enables installation of 'FINVUL-X' cables even in cramped space conditions. The cables require less support, thus lowering installation costs.

- **Lower Di-electric Constant and Power Factor :**

Results in saving in power losses which means saving in costs, particularly for higher voltage.


- **Better Impact, Abrasion, Corrosion Resistance :**

Safer than PVC Cables against mechanical damage,abrasion and corrosion.

- **Easier Jointing and Termination :**

Requires no special skills or equipment for jointing and termination.

### COMPARISON OF PROPERTIES

	FINVUL-X	PVC	IS : 7098(Part I) 	
Dielectric Constant	2.35	6 to 8		
Dielectric strength	KV/mm	22		14
Volume Resistivity at 27°C	Ohm-cm	10 <sup>14</sup>		10 <sup>13</sup>
Thermal Resistivity	°C cm/W	350		600
Power Factor at maximum conductor temperature		0.008		0.1
Normal conductor operating temperature	°C	90		70
Emergency overload temperature	°C	130		120
Maximum short circuit temperature	°C	250		160

### QUALITY ASSURANCE

- At Finolex, Quality Assurance is ensured through planned, stage-wise quality checks. These quality checks are made starting from the raw material right through every stage of manufacturing.
- In particular, the property and specified test for XLPE compound is checked and the absence of contamination in the compound is noted against each batch of material received.

**TABLE 1 : FINVUL-X 1100 V Grade Single Core, Aluminium Conductor, XLPE Insulated, Unarmoured / Armoured, PVC Jacketed Cables**

Nom. Cross Sectional Area Sq.mm	Unarmoured			Armoured				Max. DC Conductor Resistance at 20°C Ohm/km	A.C. Current Rating			
	Nom. Thickness of XLPE Insulation mm	Approx. Overall Dia. mm	Approx. Overall Weight kg/km	Nom. Thickness of Insulation mm	Nom. Dia of Alu. Wire for Armour mm	Approx. Overall Dia. mm	Approx. Weight kg/km		In Air		In Ground	
									2 Cables Amps	3 Cables Amps	2 Cables Amps	3 Cables Amps
10	0.70	9.70	106	1.00	1.40	12.10	176	3.0800	60	53	69	59
16	0.70	10.70	134	1.00	1.40	13.20	211	1.9100	82	73	90	76
25	0.90	12.30	185	1.20	1.40	14.80	276	1.2000	108	99	116	97
35	0.90	13.40	223	1.20	1.40	15.90	321	0.8680	136	122	139	116
50	1.00	15.00	277	1.30	1.40	17.50	387	0.6410	163	149	162	139
70	1.10	17.20	363	1.40	1.40	19.70	487	0.4430	208	190	199	171
95	1.10	18.70	444	1.40	1.60	21.90	617	0.3200	258	235	241	204
120	1.20	20.50	538	1.50	1.60	23.60	726	0.2530	303	276	273	231
150	1.40	22.70	666	1.70	1.60	25.50	850	0.2060	348	321	305	259
185	1.60	24.90	797	1.90	1.60	27.70	999	0.1640	407	371	347	292
240	1.70	27.30	985	2.00	1.60	30.10	1208	0.1250	488	447	407	342
300	1.80	30.10	1186	2.10	1.60	33.20	1452	0.1000	569	515	458	384
400	2.00	33.80	1511	2.40	2.00	37.50	1869	0.0778	669	606	518	440
500	2.20	37.20	1867	2.60	2.00	40.90	2261	0.0605	786	705	592	500
630	2.40	40.70	2321	2.80	2.00	44.70	2789	0.0469	922	823	666	565
800	2.60	46.40	2938	3.10	2.00	50.50	3473	0.0367	1067	949	750	629
1000	2.80	50.70	3638	3.30	2.50	55.70	4364	0.0291	1220	1076	833	704

**TABLE 2 : FINVUL-X 1100 V Grade Two Core, Aluminium Conductor, XLPE Insulated, Unarmoured / Armoured, PVC Jacketed Cables**

Nom. Cross Sectional Area Sq.mm	Nom. Thickness of XLPE Insulation mm	Unarmoured		Armoured				Max. DC Conductor Resistance at 20°C Ohm/km	A.C. Current Rating	
		Approx. Overall Dia. mm	Approx. Overall Weight kg/km	Nom. Steel Armour Size mm		Approx. Overall Dia. mm	Approx. Weight kg/km		In Air Amps	In Ground Amps
				Round Wire	Flat Strip					
10	0.70	17.30	132	1.40		18.10	530	3.08	67	71
16	0.70	19.00	147	1.40		20.40	643	1.91	88	91
25	0.90	19.60	166		4 x 0.8	19.30	582	1.200	117	120
35	0.90	21.20	181		4 x 0.8	20.90	680	0.868	145	143
50	1.00	23.70	204		4 x 0.8	23.40	821	0.641	176	167
70	1.10	27.10	236		4 x 0.8	27.10	1054	0.443	221	204
95	1.10	30.00	286		4 x 0.8	29.40	1271	0.320	271	245
120	1.20	32.70	314		4 x 0.8	32.10	1495	0.253	315	278
150	1.40	34.50	333		4 x 0.8	34.30	1769	0.206	362	315
185	1.60	38.30	401		4 x 0.8	37.90	2101	0.164	420	356
240	1.70	42.20	476		4 x 0.8	41.40	2534	0.125	497	407
300	1.80	46.70	566		4 x 0.8	46.30	3079	0.100	578	463
400	2.00	52.30	678		4 x 0.8	51.80	3834	0.0778	678	528

**TABLE 3 : FINVUL-X 1100 V Grade Three Core, Aluminium Conductor, XLPE Insulated, Unarmoured / Armoured, PVC Jacketed Cables**

Nom. Cross Sectional Area Sq.mm	Nom. Thickness of XLPE Insulation mm	Unarmoured		Armoured				Max. DC Conductor Resistance at 20°C Ohm/km	A.C. Current Rating	
		Approx. Overall Dia. mm	Approx. Overall Weight kg/km	Nom. Steel Armour Size mm		Approx. Overall Dia. mm	Approx. Weight kg/km		In Air Amps	In Ground Amps
				Round Wire	Flat Strip					
10	0.70	18.20	294	1.40		18.9	659	3.08	53	57
16	0.70	18.40	372		4 X 0.8	18.2	540	1.91	70	78
25	0.90	21.50	528		4 X 0.8	21.2	727	1.200	95	97
35	0.90	23.50	640		4 X 0.8	23.2	863	0.868	117	116
50	1.00	26.70	819		4 X 0.8	26.0	1053	0.641	140	134
70	1.10	31.10	1101		4 X 0.8	30.5	1386	0.443	176	167
95	1.10	33.60	1359		4 X 0.8	33.0	1671	0.320	221	199
120	1.20	36.80	1633		4 X 0.8	36.2	1982	0.253	258	227
150	1.40	39.30	1995		4 X 0.8	38.9	2386	0.206	294	255
185	1.60	43.50	2428		4 X 0.8	43.0	2854	0.164	339	287
240	1.70	48.10	3043		4 X 0.8	47.7	3528	0.125	402	333
300	1.80	53.80	3760		4 X 0.8	52.8	4232	0.100	461	375
400	2.00	59.80	4723		4 X 0.8	59.3	5318	0.0778	542	426

**TABLE 4 : FINVUL-X 1100 V Grade 3.5 Core, Aluminium Conductor, XLPE Insulated, Unarmoured / Armoured, PVC Jacketed Cables**

Nom. Cross Sectional Area Sq.mm	Nom. Thickness of XLPE Insulation mm main core	Unarmoured		Armoured			Max. DC Conductor Resistance at 20°C Ohm/km	A.C. Current Rating	
		Approx. Overall Dia. mm	Approx. Overall Weight kg/km	Nom. Steel Armour Size mm	Approx. Overall Dia. mm	Approx. Weight kg/km		In Air	In Ground
								Amps	Amps
25	0.90	23.10	604.00	4 X 0.8	22.8	821.0	1.200	95	97
35	0.90	25.20	719.00	4 X 0.8	24.9	961.0	0.868	117	116
50	1.00	28.80	940.00	4 X 0.8	28.1	1195.0	0.641	140	134
70	1.10	33.60	1258.00	4 X 0.8	33.0	1569.0	0.443	176	167
95	1.10	36.40	1560.00	4 X 0.8	35.8	1903.0	0.320	221	199
120	1.20	39.20	1896.00	4 X 0.8	39.0	2303.0	0.253	258	227
150	1.40	43.30	2284.00	4 X 0.8	42.9	2720.0	0.206	294	255
185	1.60	48.00	2800.00	4 X 0.8	47.5	3276.0	0.164	339	287
240	1.70	53.10	3506.00	4 X 0.8	52.7	4048.0	0.125	402	333
300	1.80	59.30	4343.00	4 X 0.8	58.4	4872.0	0.100	461	375
400	2.00	66.40	5492.00	4 X 0.8	65.6	6101.0	0.0778	542	426

**TABLE 5 : FINVUL-X 1100 V Grade 4 Core, Aluminium Conductor, XLPE Insulated, Unarmoured / Armoured, PVC Jacketed Cables**

Nom. Cross Sectional Area Sq.mm	Nom. Thickness of XLPE Insulation mm	Unarmoured		Armoured			Max. DC Conductor Resistance at 20°C Ohm/km	A.C. Current Rating		
		Approx. Overall Dia. mm	Approx. Overall Weight kg/km	Nom. Steel Armour Size mm		Approx. Overall Dia. mm		Approx. Weight kg/km	In Air	In Ground
				Round Wire	Flat Strip				Amps	Amps
10	0.70	19.70	367.0			21.10	713.0	3.08	53	57
16	0.70	20.00	449.0		4 X 0.8	20.20	653.0	1.91	70	78
25	0.90	24.00	652.0		4 X 0.8	23.70	882.0	1.200	95	97
35	0.90	26.20	798.0		4 X 0.8	26.00	1055.0	0.868	117	116
50	1.00	29.60	1002.0		4 X 0.8	29.70	1317.0	0.641	140	134
70	1.10	35.10	1387.0		4 X 0.8	34.60	1717.0	0.443	176	167
95	1.10	38.10	1726.0		4 X 0.8	37.60	2091.0	0.320	221	199
120	1.20	42.30	2123.0		4 X 0.8	42.00	2550.0	0.253	258	227
150	1.40	45.20	2597.0		4 X 0.8	44.80	3042.0	0.206	294	255
185	1.60	50.60	3203.0		4 X 0.8	49.70	3647.0	0.164	339	287
240	1.70	55.80	4016.0		4 X 0.8	55.00	4523.0	0.125	402	333
300	1.80	62.00	4900.0		4 X 0.8	61.40	5482.0	0.100	461	375
400	2.00	69.40	6223.0		4 X 0.8	68.60	6846.0	0.0778	542	426

Note : 1. Cables with copper conductor as well as with round wire armoured can also be supplied on request.

2. BIS licence number CM/L-1486562

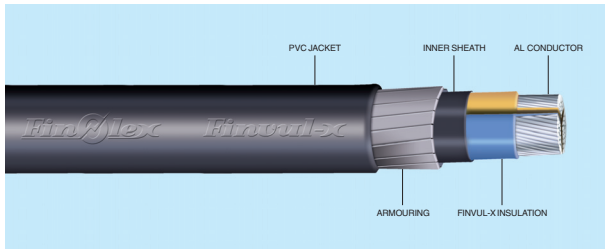
## RECOMMENDATIONS FOR STORAGE AND INSTALLATION OF CABLES

### For easy and convenient installation for desired performance :

- Cable drums should be stored on a plain vibration-free ground, without any hard stones projecting above the surface. The drums should preferably be stored in the shade.
- Drums should be stored and kept in such a way that the bottom end of the cable does not get damaged.
- Cable drums should not be stored one above the other.
- Drums should be rotated only in the direction marked on the drum.
- While laying the cable in a trench, the cable end should be pulled with a pulling eye only after mounting the drum on the jacks. Do not keep the drum on its flange while pulling the cable. This will result in the twist in the cable.
- Drums should be checked for continuity and cross continuity to ensure that there is no internal damage to the cable during transportation.
- Insulation resistance should be measured with 500 V megger between the cores and all the cores to earth (Armour).
- After the cable is installed, before commissioning, it should be tested for DC high voltage test. The recommended voltage and duration of the test between each core and metallic armour (earth) is 3 KVDC for 5 minutes. During High Voltage test, all the electrical equipment related to the cable installation must be earthed and adequate clearance should be maintained from other equipments at work, to prevent flash over.
- Where the cable is to be joined with an existing cable, the sequence of cores at the two ends to be joined should be in the opposite direction i.e., if at one end it is in the clockwise direction, at the other end it should be in the anti-clockwise direction. This is necessary to avoid the crossing of cores while jointing. This will also decide the direction in which the cable is to be pulled.
- The minimum bending radius of the cable should not be less than the values indicated below. Wherever possible 25% higher value should be adopted.
  - 15 x overall diameter: Single core cables as per table 1
  - 12 x overall diameter: Multicore cables as per tables 2, 3, 4 and 5
- Avoid excessively high temperature when sealing joints of cable. Cool the sealant to about 100°C before pouring.

All information given herein is in good faith. Finotex shall not be liable for any damages arising out of incorrect use or interpretation.

## TYPICAL CABLE CONSTRUCTION



### CONDUCTOR :

Conductors are made from Electrolytic grade high pure aluminium conforming to IS 8130/1984 and are compact circular or compact sector shaped. Copper conductor cables can also be offered against specific request.

### INSULATION :

FINVUL-X cables are specially manufactured with high dielectric grade cross-linked polyethylene for insulation and is applied by extrusion process.

### CORE IDENTIFICATION :

The cores are identified by different colours :

Single core	Red/natural
Two core	Red, black
Three core	Red, yellow, blue
Four core	Red, yellow, blue, black
Three and half core	Red, yellow, blue and reduced neutral core in black

### LAYING UP :

In multicore cables, cores are laid up as per the above colour scheme.

### INNER SHEATH :

Laid up cores are bedded over with thermoplastic material for protection against mechanical damage.

### ARMOURING :

Armouring is provided over the inner sheath to guard against mechanical damage. Armouring is generally of galvanised steel wires or strips. In single core cables, used in AC system, armouring is by non-magnetic hard drawn aluminium wires. Round steel wires are used where the diameter over the inner sheath does not exceed 13 mm, above 13 mm, flat steel strip armour is used. Round wire of different sizes can also be provided against specific request.

### PVC JACKET :

Specially formulated heat resistant black PVC compound ST2 type as per IS 5831:1984 and is extruded to form the jacket. Finolex also offers specially formulated Flame Retardant Low Smoke (FRLS) compound for jacket used in fire hazardous environment.

### TESTS

In addition to all tests required as per IS 7098 (Part I) 1988, FINVUL-X cables are subjected to a number of in-house tests at every stage of production. Incoming raw material is also tested thoroughly to ensure consistency of quality. The cables are marked with ISI mark.

### PRODUCT CODE :

As per IS 7098 (Part I) 1988, the codes are :

Constituent	Code
Aluminium conductor	A
FINVUL-X insulation	2X
Steel round wire armour	W
Steel strip armour	F
Steel double round wire armour	WW
Steel double strip armour	FF
PVC jacket	Y

### LENGTH :

FINOLEX provides continuous length of 500 meters  $\pm$  10% for single/multi-core armoured and unarmoured cables up to 400 sq.mm. Sizes above 400 sq.mm. are generally packed in 250 metres  $\pm$  10%. The cables are progressive sequentially marked on every 1 meter length for ease of length measurement.

### PACKING AND MARKING

FINVUL-X cables are wound on sturdy, non-returnable wooden drums built to withstand the weight of the cable as well as handling abuses. Each drum is marked with particulars required under IS 7098 (Part I) 1988.

## SHORT CIRCUIT RATING

The conductor size in a cable for any type of insulation is governed by its ability to carry short circuit current of the system.

The short circuit ratings are based on the assumption that the duration of short circuit is very small, and apparently there is no heat transmitted or produced during shortcircuit, through the insulation the heat produced if any, the entire amount is absorbed by the conductor.

The short circuit current ratings (r.m.s.values) of XLPE insulated cables with aluminium conductors for one second duration are calculated on the following assumptions:

- Conductor temperature prior to short circuit 90°C
- Maximum permissible conductor temperature during short circuit 250°C
- Specific gravity of aluminium 2.703
- Specific heat of aluminium 0.22 Cal/gm°C
- Resistivity of Aluminium 28.264 ohm/km/sqmm
- Temperature coefficient of resistance at 20°C 0.00403°C

Comparative maximum shortcircuit rating of PVC and Finvul-x insulated cables for a duration of one second in kiloamps for aluminium conductor.

Nominal area of cross section sqmm	FINVUL-X	PVC
	kiloamps	kiloamps
10	0.966	0.743
16	1.550	1.173
25	2.420	2.036
35	3.370	2.536
50	4.790	3.653
70	6.680	5.518
95	9.030	6.874
120	11.400	9.075
150	14.200	11.265
185	17.500	13.894
240	22.600	18.024
300	28.200	22.057
400	37.600	31.760
500	47.000	34.100
630	58.000	44.000
800	74.400	56.300
1000	93.000	71.000

Formula for calculating the short circuit rating for other durations :

$$I_t = \frac{I_1}{\sqrt{t}}$$

where: I<sub>1</sub> = Short Circuit current for 1 sec

I<sub>t</sub> = Short Circuit current for t sec

t = Duration in seconds

## RATING FACTORS

- Rating factors for ambient air temperature variation

Ambient Temperature (°C)	25	30	35	40	45	50
Factor	1.18	1.12	1.06	1.0	0.94	0.88

- Rating factors for ambient ground temperature variation

Ground Temperature (°C)	15	20	25	30	35	40	45	50
Factor	1.12	1.08	1.04	1.00	0.96	0.91	0.86	0.81

- Rating factor for various depths of laying (for cables laid directly in ground)

Depth of laying	Upto 25 mm <sup>2</sup>	Above 25 mm <sup>2</sup> upto 300 mm <sup>2</sup>	Above 300 mm <sup>2</sup>
75 cm	1.0	1.0	1.0
90 cm	0.99	0.98	0.97
105 cm	0.98	0.97	0.96
120 cm	0.97	0.96	0.95
150 cm	0.96	0.94	0.92
180 cm or more	0.95	0.93	0.91