

# MLFC<sup>®</sup>

Flame-Retardant Polyflex Insulated Wires



***'MLFC' is suitable for a variety of uses as a motor lead wire or switchboard wire, etc.***



# Characteristics

## 1 Compatible with flame-retardant crosslinked polyethylene compound

Insulation is compatible with flame-retardant crosslinked polyethylene compound, which is specified in the Japanese Electrical Appliance and Material Safety Law.

## 2 Flame-retardant

Same level or higher flame retardance than chloroprene rubber can be obtained, and no specified brominated flame retarder is contained.

## 3 Compliant with RoHS

As indicated in 2002/95/EC "limitation of usage of specified hazardous chemical substances contained in electrical appliances and materials "

## 4 High flexibility

Combination of the flexibility-improved insulation and flexible stranded conductor has actualized excellent flexibility and wiring performance.

## 5 High tracking and corona resistance

Superior tracking and corona resistance required for high-voltage wires are available up to 6600V.

## 6 High cold resistance

Excellent cold resistance of min. permissible conductor temperature down to -50 degrees °C.

●For applications to be subjected to vibration, bending, or impact, please make sure to consult us in advance.

## 7 High varnish resistance

Superior compatibility with coil varnish to be used at electrical work on motors.

●It is necessary to consult us in advance since results of compatibility evaluation should depend on the type or condition of varnish treatment.

## 8 High heat resistance

Excellent heat-resistance up to 120 degrees °C for 20000-hour lifetime, and up to 110 degrees °C for 40000-hour lifetime. (ref. Figure 1)

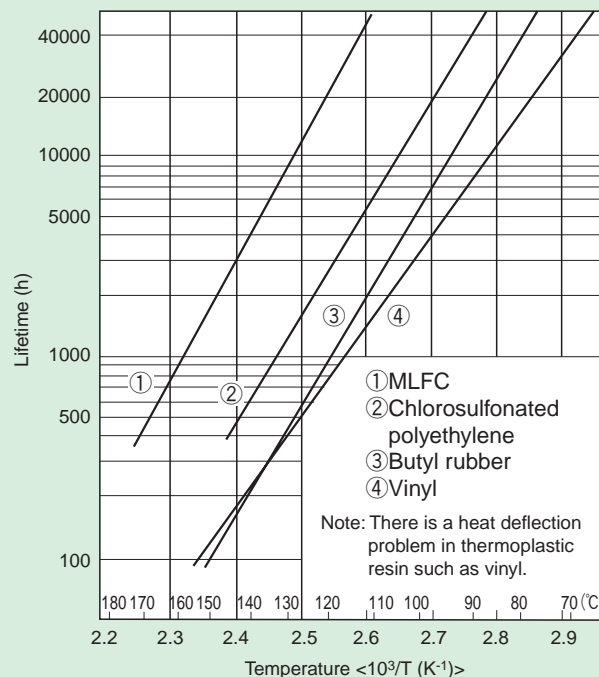


Figure 1. Heat-resistant lifetime properties

**Table 1. Property comparison**

Item		600V MLFC	HIV	6600V MLFC	6600V KIP	
Structure specifications	Insulation	Flame-retardant XLPE	Heat-resistant PVC	Flame-retardant XLPE	EP rubber	
	Max. permissible conductor temperature (Note 1)	90°C (110°C)	75°C	90°C (110°C)	80°C	
	Ampacity	100	85	100	90	
	Outer diameter	100	80~100	100	90~100	
Advantages and disadvantages on wiring	Flexibility	Excellent	Fair	Excellent	Good	
	Wear resistance	Excellent	Good	Excellent	Good	
	Film coating removal performance on wire terminals	Good	Good	Good	Good	
Performance	Corona resistance	—	—	Excellent	Excellent	
	Tracking resistance	—	—	Excellent	Excellent	
	Heat deflection resistance	Excellent	Fair	Excellent	Excellent	
	Heat winding performance (180 degrees °C x 6 days with winding diameter 4 times larger than the wire's)	Good	Poor	Good	Good	
	Physical properties	Enlongation (%)	400~600	200~300	400~600	500~600
		Tensile strength (MPa)	15~25	10~25	15~25	7~10
		Hardness (Hs)	75 (Shore A)	50 (Shore D)	75 (Shore A)	65 (Shore A)
		Tear resistance (N/cm)	100	200	100	50
	Flammability	Self-extinguishing performance	Excellent	Good	Excellent	Poor (Note 2)
		HCl gas generation volume (Note 3)	50~60	300~400	50~60	0
	Cold-resistance	Excellent	Fair	Excellent	Excellent	
	Varnish resistance	Excellent	Excellent (except for heat deflection)	Excellent	Excellent	
	Weather resistance	Excellent	Excellent	Excellent	Excellent	
	Oil resistance	Good	Good	Good	Poor	
Ozone resistance	Excellent	Excellent	Excellent	Very excellent		

Note 1: The max. conductor temp indicated in parentheses is applied when used as a lead wire.

Note 2: Flame retardant EP rubber is available.

Note 3: Indicated values show the HCl gas generation volume (mg) per 1g of insulation.

## Product Designation

Product designation depends on voltage, code, and nominal cross-section (size).

Example: 600V MLFC 14mm<sup>2</sup>

**Table 2. Marking**

Wire type		Marking	
600V MLFC	0.75mm <sup>2</sup>	WL1	<PS>E HITACHI TAINEN 600V MLFC 0.75mm <sup>2</sup> Year of manufacture
	1.25mm <sup>2</sup>	WL1-A	<PS>E HITACHI TAINEN 600V MLFC 1.25mm <sup>2</sup> Year of manufacture
	2 mm <sup>2</sup>	WL1-B	<PS>E HITACHI TAINEN 600V MLFC 2mm <sup>2</sup> Year of manufacture
	3.5 mm <sup>2</sup>	WL1-C	<PS>E HITACHI TAINEN 600V MLFC 3.5mm <sup>2</sup> Year of manufacture
	5.5 mm <sup>2</sup>	WL1-D	<PS>E HITACHI TAINEN 600V MLFC 5.5mm <sup>2</sup> Year of manufacture
	8~100mm <sup>2</sup>	WL1	<PS>E HITACHI TAINEN 600V MLFC size Year of manufacture
	Other sizes	WL1	HITACHI 600V MLFC size Year of manufacture
1500V MLFC	1.25mm <sup>2</sup>	WL2-A	HITACHI 1500V MLFC 1.25mm <sup>2</sup> Year of manufacture
	2 mm <sup>2</sup>	WL2-B	HITACHI 1500V MLFC 2mm <sup>2</sup> Year of manufacture
	3.5 mm <sup>2</sup>	WL2-C	HITACHI 1500V MLFC 3.5mm <sup>2</sup> Year of manufacture
	5.5 mm <sup>2</sup>	WL2-D	HITACHI 1500V MLFC 5.5mm <sup>2</sup> Year of manufacture
	Other sizes	WL2	HITACHI 1500V MLFC size Year of manufacture
3300V MLFC		3300V	MLFC HITACHI Year of manufacture
6600V MLFC		6600V	MLFC HITACHI Year of manufacture

Remarks: 600V and 1500V wires (WL1 and WL2) can be used in rolling stock.

**Table 3. Ampacities for 600~6600V MLFC**

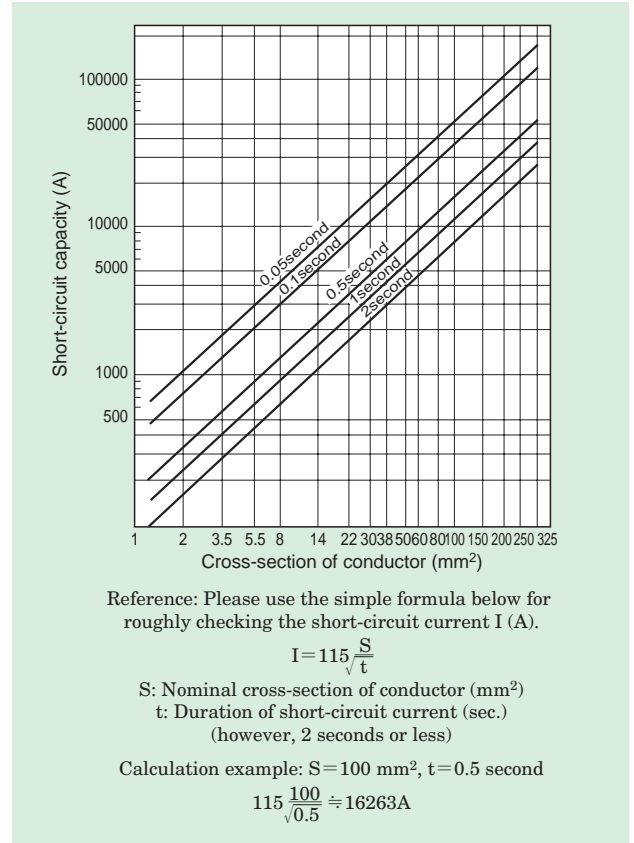
Ambient temperature: 40 degrees °C

Cross-section of conductor (mm <sup>2</sup> )	Permissible conductor temp. (degrees °C)	110°C (Rated temperature)	(Note 4) 90°C	(Note 4) 75°C	(Note 4) 60°C
	325		994	838	702
250		850	717	600	455
200		717	605	506	384
150		604	509	426	323
125		526	443	371	282
100		455	384	321	244
80		393	331	277	210
60		332	279	234	177
50		290	245	205	155
38		247	208	174	132
30		212	179	150	113
22		175	148	124	94
14		134	113	95	72
8		93	78	65	50
5.5		74	63	52	40
3.5		56	47	39	30
2.0		41	34	29	22
1.25		29	24	20	15
0.75		22	19	16	12

Note 4: Max. conductor temperature is 110 degrees °C. Please refer to the indicated values of permissible current if the conductor temperature shall be restricted to 90 degrees °C, 75 degrees °C, or 60 degrees °C in accordance with applications.

**Figure 2. Short-circuit capacity of MLFC**

Calculation condition Pre-short-circuit conductor temp.: 110 degrees °C  
In-short-circuit max. permissible temp.: 230 degrees °C



If ampacity at ambient temperature differs from 40 degrees °C, they can be obtained by multiplying a correction factor for the actual ambient temperature as shown in Table 4.

**Table 4. Correction factors**

Ambient temp. (degrees °C)	Permissible conductor temp. (degrees °C)			
	110°C	90°C	75°C	60°C
30	1.06	1.09	1.13	1.22
40	1.00	1.00	1.00	1.00
50	0.925	0.894	0.845	0.707
60	0.845	0.774	0.654	—
Trial calculation formula θ = ambient temperature	$\sqrt{\frac{110 - \theta}{70}}$	$\sqrt{\frac{90 - \theta}{50}}$	$\sqrt{\frac{75 - \theta}{35}}$	$\sqrt{\frac{60 - \theta}{20}}$

For using in a switchboard or multiple cabling in air, please multiply the ampacities indicated in Table 3 by the following reduction ratio to obtain correct values.

**Table 5. Reduction ratio for use in a switchboard**

No. of wiring	Reduction ratio
2	0.9
3	0.7
6	0.55

Reference: No.T003 issued by the Japan Switchboard Industries Association.

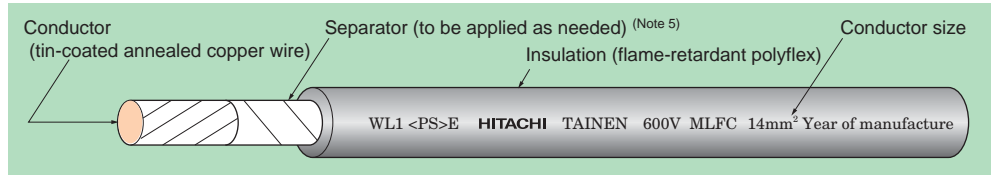
**Table 6. Reduction ratio for multi cabling in air (for reference)**

No. of wires	Reduction ratio					
	1	2	3	6	4	6
Arrangement						
Clearance between centers of the adjacent wire conductors						
S=d		0.85	0.80	0.70	0.70	0.60
S=2d	1.00	0.95	0.95	0.90	0.90	0.90
S=3d		1.00	1.00	0.95	0.95	0.95

d = Outer diameter of the wire

Reference: the JCS (Japanese Cable Makers' Association Standard)-168 E

# Structure and performance



Note 5: No separator shall be applied for 600~3300V wires with the conductor size of 3.5 mm<sup>2</sup> or less.

**Table 7. 600V MLFC**

Nominal cross-section (mm <sup>2</sup> )	Conductor		Insulation thickness (mm)	Overall diameter (mm)	Conductor resistance (20 degrees °C) (Ω/km)	Test voltage (V)	Insulation resistance (20 degrees °C) (MΩ · km)	Resistance to surface leakage (MΩ)	Reference	
	Structure No. of strand/strand diameter (mm)	Outer diameter (approx.) (mm)							Approx. Mass (kg/km)	Standard length of wire (m)
325	37/55/0.45	27.0	2.9	30.8~33.2	0.0614	3500	20	50	3300	300
250	37/42/0.45	23.6	2.9	28.0~29.6	0.0760	3000	20	50	2550	300
200	37/34/0.45	21.2	2.9	25.1~26.9	0.0939	3000	20	60	2100	300
150	27/34/0.45	18.7	2.3	21.7~22.7	0.129	3000	20	70	1500	300
125	19/42/0.45	16.8	2.3	20.0~22.2	0.148	3000	20	70	1350	300
100	19/34/0.45	15.2	2.3	18.5~20.3	0.183	3000	30	80	1100	300
80	19/27/0.45	13.5	1.8	15.8~17.6	0.230	2500	30	90	860	300
60	19/20/0.45	11.6	1.8	14.0~15.6	0.311	2500	30	100	650	300
50	19/16/0.45	10.4	1.8	12.8~14.4	0.389	2500	30	100	530	300
38	7/34/0.45	9.1	1.4	11.0~12.4	0.496	2500	40	100	410	100
30	7/27/0.45	8.1	1.4	10.0~11.4	0.625	2200	40	100	330	100
22	7/20/0.45	7.0	1.4	8.9~10.3	0.844	2200	40	100	260	100
14	88/0.45	4.9	1.1	6.4~ 7.6	1.32	2200	40	200	160	200
8	50/0.45	3.7	1.1	5.2~ 6.4	2.32	2200	50	200	100	200
5.5	35/0.45	3.1	1.1	4.6~ 5.8	3.31	2200	50	300	70	400
3.5	45/0.32	2.5	1.1	4.0~ 5.2	5.38	2200	50	300	50	400
2.0	37/0.26	1.8	1.1	3.4~ 4.4	9.91	2200	60	300	30	400
1.25	50/0.18	1.5	1.1	3.1~ 4.1	15.5	2200	70	300	25	400
0.75	30/0.18	1.1	1.1	2.8~ 3.7	25.8	2200	80	300	20	400

**Table 8. 1500V MLFC**


Nominal cross-section (mm <sup>2</sup> )	Conductor		Insulation thickness (mm)	Overall diameter (mm)	Conductor resistance (20 degrees °C) (Ω/km)	Test voltage (V)	Insulation resistance (20 degrees °C) (MΩ · km)	Resistance to surface leakage (MΩ)	Reference	
	Structure No. of strand/strand diameter (mm)	Outer diameter (approx.) (mm)							Approx. Mass (kg/km)	Standard length of wire (m)
250	37/42/0.45	23.6	3.0	28.6~31.0	0.0760	5400	20	50	2600	300
200	37/34/0.45	21.2	3.0	26.3~28.5	0.0939	5400	20	50	2150	300
150	27/34/0.45	18.7	2.5	22.9~24.9	0.129	5400	20	60	1600	300
125	19/42/0.45	16.8	2.5	21.1~23.1	0.148	5400	20	70	1400	300
100	19/34/0.45	15.2	2.5	19.4~21.4	0.183	5400	30	70	1150	300
80	19/27/0.45	13.5	2.5	17.8~19.6	0.230	5400	30	90	920	300
60	19/20/0.45	11.6	2.5	16.0~17.6	0.311	5400	30	90	700	300
50	19/16/0.45	10.4	2.5	14.8~16.4	0.389	5400	40	100	580	300
38	7/34/0.45	9.1	2.0	12.5~14.1	0.496	5400	30	100	450	100
30	7/27/0.45	8.1	2.0	11.6~13.0	0.625	5400	40	100	370	100
22	7/20/0.45	7.0	2.0	10.5~11.9	0.844	5400	45	100	300	100
14	88/0.45	4.9	2.0	8.3~ 9.7	1.32	5400	50	100	180	200
8	50/0.45	3.7	2.0	7.2~ 8.4	2.32	5400	60	200	120	200
5.5	35/0.45	3.1	2.0	6.6~ 7.8	3.31	5400	70	200	90	200
3.5	45/0.32	2.5	2.0	6.0~ 7.2	5.38	5400	80	200	70	200
2.0	37/0.26	1.8	2.0	5.3~ 6.5	9.91	5400	100	200	50	400
1.25	50/0.18	1.5	2.0	5.1~ 6.1	15.5	5400	110	200	40	400

**Table 9. 3300V MLFC**

Conductor			Insulation thickness (mm)	Overall diameter (mm)	Conductor resistance (20 degrees ℃) (Ω/km)	Test voltage (V)	Insulation resistance (20 degrees ℃) (MΩ · km)	Resistance to surface leakage (MΩ)	Reference	
Nominal cross-section (mm <sup>2</sup> )	Structure No. of strand/strand diameter (mm)	Outer diameter (approx.) (mm)							Approx. Mass (kg/km)	Standard length of wire (m)
250	37/42/0.45	23.6	3.5	29.3~32.3	0.0760	8000	20	50	2650	300
200	37/34/0.45	21.2	3.5	27.0~29.8	0.0939	8000	30	50	2200	300
150	27/34/0.45	18.7	3.0	23.7~26.1	0.129	8000	30	60	1650	300
125	19/42/0.45	16.8	3.0	21.9~24.3	0.148	8000	30	60	1450	300
100	19/34/0.45	15.2	3.0	20.3~22.5	0.183	8000	30	70	1200	300
80	19/27/0.45	13.5	3.0	18.7~20.7	0.230	8000	30	80	960	300
60	19/20/0.45	11.6	3.0	16.9~18.7	0.311	8000	40	90	740	300
50	19/16/0.45	10.4	3.0	15.7~17.4	0.389	8000	40	90	600	300
38	7/34/0.45	9.1	2.5	13.5~15.0	0.496	8000	40	100	480	100
30	7/27/0.45	8.1	2.5	12.5~14.0	0.625	8000	40	100	400	100
22	7/20/0.45	7.0	2.5	11.4~12.8	0.844	8000	50	100	310	100
14	88/0.45	4.9	2.5	9.3~10.5	1.32	8000	60	100	200	200
8	50/0.45	3.7	2.5	8.2~ 9.3	2.32	8000	70	100	130	200
5.5	35/0.45	3.1	2.5	7.6~ 8.7	3.31	8000	80	100	110	200
3.5	45/0.32	2.5	2.5	7.0~ 8.1	5.38	8000	90	200	80	200
2.0	37/0.26	1.8	2.5	6.3~ 7.4	9.91	8000	110	200	60	400

**Table 10. 6600V MLFC**

Conductor			Insulation thickness (mm)	Overall diameter (mm)	Conductor resistance (20 degrees ℃) (Ω/km)	Test voltage (V)	Insulation resistance (20 degrees ℃) (MΩ · km)	Resistance to surface leakage (MΩ)	Reference	
Nominal cross-section (mm <sup>2</sup> )	Structure No. of strand/strand diameter (mm)	Outer diameter (approx.) (mm)							Approx. Mass (kg/km)	Standard length of wire (m)
250	37/42/0.45	23.6	4.5	31.0~34.2	0.0760	18000	30	50	2750	300
200	37/34/0.45	21.2	4.5	28.7~31.7	0.0939	18000	30	50	2300	300
150	27/34/0.45	18.7	4.0	25.4~28.0	0.129	18000	30	60	1700	300
125	19/42/0.45	16.8	4.0	23.7~26.1	0.148	18000	30	60	1500	300
100	19/34/0.45	15.2	4.0	22.0~24.4	0.183	18000	40	60	1250	300
80	19/27/0.45	13.5	4.0	20.4~22.6	0.230	18000	40	70	1050	300
60	19/20/0.45	11.6	4.0	18.6~20.6	0.311	18000	50	80	790	300
50	19/16/0.45	10.4	4.0	17.5~19.3	0.389	18000	50	80	660	300
38	7/34/0.45	9.1	4.0	16.2~18.0	0.496	18000	50	90	560	300
30	7/27/0.45	8.1	4.0	15.2~16.9	0.625	18000	60	90	470	100
22	7/20/0.45	7.0	4.0	14.2~15.8	0.844	18000	60	100	380	100
14	88/0.45	4.9	4.0	12.1~13.5	1.32	18000	80	100	270	100
8	50/0.45	3.7	4.0	11.0~12.3	2.32	18000	100	100	190	200
5.5	35/0.45	3.1	4.0	10.4~11.7	3.31	18000	110	100	160	200
3.5	45/0.32	2.5	4.0	9.8~11.2	5.38	18000	120	100	130	200

 Please make sure to follow the precautions below for wire installation.

## Precautions for wire installation

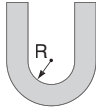
### (1) Insulation distance

Make sure to use wiring supporters, such as an insulator or insulation spacer, etc. to keep the insulation distance indicated in the Table 11 and creepage distance of 130 mm or more for wire installation.

### (2) Permissible bending radius

Permissible bending radius (R) for fixation shall be  $R \geq 4d$ .

(d: outer diameter of the wire)



Calculation example: for 600V MLFC 100mm<sup>2</sup>

$$R \geq 4(d = 20.3\text{mm}) \\ \geq 81.2\text{mm}$$

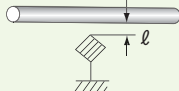
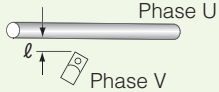
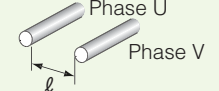
## Stock

As shown in the Table 12, we offer a large number of variations for each voltage from our stock.

## Specifications

- Specification sheet SP39-10021N: Flame-retardant polyflex wires
- Environmentally friendly type non-halogen wires are also available.  
Specification sheet SP39-10950E: ECO GREEN<sup>®</sup> flame-retardant non-halogen crosslinked polyethylene wires 'EM-MLFC'
- UL-approved products are also available and to be selected according to application as follows.  
For internal wiring: UL Style 1505 (rating: 600V at 105 degrees °C)  
For switchboard wiring: Type SIS (rating: 600V at 90 degrees °C DRY)
- Wires provided with high heat-resistance (rating: 125 degrees °C) are also available.  
600V flame-retardant heat-resistant crosslinked polyethylene wires '600V MLFC-III'

**Table 11. Insulation distance for MLFC**

No.	Wiring conditions	3300V	6600V	Remarks
1	Distance between grounded metal object and wire surface: $\ell$ (mm)	5 or more	15 or more	
2	Distance between heterophase bare metal and wire surface: $\ell$ (mm)	15 or more	15 or more	
3	Distance between adjacent heterophase wires: $\ell$ (mm)	0 or more	15 or more	

**Table 12. Stock list**

Cross-section of conductor (mm <sup>2</sup> )	600V	1500V	3300V	6600V
325	○	—	—	—
250	○	○	—	—
200	○	○	○	○
150	○	○	○	○
125	○	○	—	—
100	○	○	○	○
80	○	○	○	○
60	○	○	○	○
50	○	○	—	—
38	○	○	○	○
30	○	—	—	—
22	○	○	○	○
14	○	○	○	○
8	○	○	○	○
5.5	○	○	○	○
3.5	○	○	○	—
2	○	○	—	—
1.25	○	—	—	—
0.75	○	—	—	—

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\*Be aware that the product line-up indicated in this catalogue may be changed for improvement without prior notice.