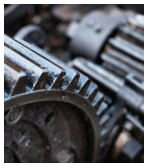
CABLE ATTRIBUTES

OIL RESISTANCE

FLAME RESISTANCE

MOTION TYPE



MECHANICAL PROTECTION

Over 50 years ago, company founder Oskar Lapp designed and manufactured the world's first flexible multi-conductor control cable. Ever since the Lapp Group has been known as the worldwide leader in flexible cable technology.

Through continual R&D and the extensive knowledge of our engineers, the Lapp Group has developed criteria which will aid the cable user in deciding which cable is best suited to their application.

As you will find on the following pages, the Lapp Group has reached a new level for specifying the following cable attributes: Oil Resistance, Flame Resistance, Motion Type, and Mechanical Protection. By setting the criteria for such important attributes, our engineers have given the cable buyer a more precise and definitive way to choose the cable that's right for their specific application or environment.

The symbols located at the top of the page can be found on the cable product pages within this catalog. To help you choose the Lapp cable that best suits your requirements, we suggest you review the criteria and definitions on the following pages and familiarize yourself with the different levels.

The Lapp Group continually strives to provide creative solutions and the highest quality products that you have come to expect.

These criteria are to be used as guidelines, and not definitive test results. Please contact your Lapp sales representative for specific testing results.

OIL RESISTANCE

Level	USA	CSA*	Europe*
OR-00	Minimum oil resistance characteristics	–	–
OR-01	UL 758 In oil for 7 days @ 60°C 75% Unaged Tensile Strength 75% Unaged Elongation	C22.2 No. 49 In oil for 7 days @ 60°C 75% Unaged Tensile Strength 75% Unaged Elongation	VDE 0281 Part 1 In oil for 7 days @ 60°C ± 30% Unaged Tensile Strength ± 30% Unaged Elongation
OR-02	UL Oil Res. I In oil for 4 days @ 100°C 50% Unaged Tensile Strength 50% Unaged Elongation	C22.2 No. 230 In oil for 4 days @ 100°C 50% Unaged Tensile Strength 50% Unaged Elongation	VDE 0472 Sect. 803A In oil for 1 day @ 100°C ± 25% Unaged Tensile Strength ± 25% Unaged Elongation
OR-03	UL Oil Res. II In oil for 60 days @ 75°C 65% Unaged Tensile Strength 65% Unaged Elongation	C22.2 No. 210.2 In oil for 4 days @ 100°C 65% Unaged Tensile Strength 65% Unaged Elongation	SEV TP 20 B In oil for 30 days @ 70°C No cracking after bending
OR-04	UL AWM 21098 In oil for 60 days @ 80°C 65% Unaged Tensile Strength 65% Unaged Elongation	C22.2 No 0.3 In oil for 60 days @ 80°C 65% Unaged Tensile Strength 65% Unaged Elongation	VDE 0472 Sect. 803B In oil for 7 days @ 90°C ± 25% Unaged Tensile Strength ± 25% Unaged Elongation
OR-05	In oil for 4 weeks @ 100°C 40% Unaged Tensile Strength 40% Unaged Elongation	–	–
OR-06	In oil for 7 days @ 180°C 80% Unaged Tensile Strength 60% Unaged Elongation	–	–

The type of industrial environment and other factors such as the duration of oil exposure and quantity of the liquid all attribute to the specific level of oil protection needed. Other parameters, such as the surrounding ambient temperature of the oil and the cable itself, will also play a role in determining the cables ability to withstand this type of chemical exposure. In general, the greater the ability of the cable jacket to resist the possible devastating effects of oil, the longer it will perform uninterrupted in the application. Certain industries (grinding, machine tools, etc.) will require the highest degree of oil resistance available, while other applications (office buildings, residential dwellings, etc.) will only need a minimal amount of this type of protection. The Lapp Group provides a large product offering of cables in a wide array of different constructions that will meet the varying degrees of oil resistance required for your application.

*Note: These oil immersion standards are mentioned for purposes of reference only. Some Canadian and European test standards are not necessarily represented here as complete equivalents to the US Standards but have been referenced due to similarities in requirements. Refer to the individual standards for detailed test procedures and any comparable evaluations.

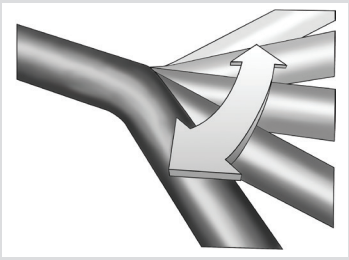
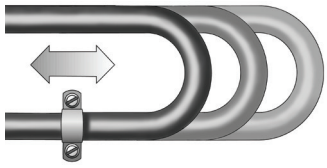
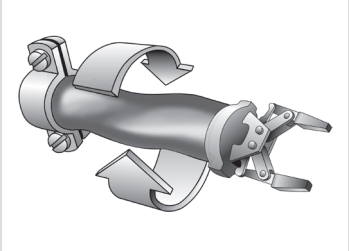
FIRE RESISTANCE

Level	USA	CSA*	Europe*
FR-00	Minimum flame retardancy: cable ignites and burns easily, and will not extinguish itself.	–	–
FR-01	UL 62: Horizontal Flame Test One 30-second flame application. Cable must not emit flame or glowing particles.	FT2: One 30-second flame application. Cable must not emit flame or glowing particles.	VDE 0472 Part 804 One 1-minute flame application. Cable must not ignite or emit flames.
FR-02	UL VW-1 (UL 1581): Vertical Flame Test Five 15-second flame applications. Cable must not emit flame or glowing particles.	FT1: Vertical Flame Test Five 15-second flame applications. Cable must not emit flame or glowing particles.	IEC 60332-1 Flame application time varies by cable diameter. Cable must self-extinguish.
FR-03	UL 1581: Vertical Tray Test Exposed to flame (70,000 BTU) for 20 min. Damage cannot exceed 8 feet.	FT4: Vertical Tray Test Exposed to flame for 20 min. Damage cannot exceed 5 feet.	IEC 60332-3-24 Exposed to flame for 20 min. Damage cannot exceed 8.2 feet.
FR-04	UL Vertical Flame and Smoke Test Exposed to flame for 20 min. Damage cannot exceed 8 feet. Smoke release not to exceed 95 m^2 and peak smoke release rate does exceed 0.25 m^2.	FT4-ST1: Vertical Flame and Smoke Test Exposed to flame for 20 min. Damage cannot exceed 5 feet. Smoke release not to exceed 150 m^2 and peak smoke release rate does exceed 0.40 m^2.	IEC 60332-3-25 Exposed to flame for 20 min. Damage cannot exceed 8.2 feet.
FR-05	UL Flame Test for Riser Cables (UL 1666: 527,500 BTU) Flame spread cannot exceed 12 feet. Measured temperature at any point cannot be greater than 850°F.	–	–
FR-06	UL Flame Test for Plenum Cables (UL 910: 300,000 BTU) Exposed to flame for 20 min. Damage cannot exceed 5 feet, peak smoke optical density not to exceed .50.	FT6 Exposed to flame for 20 min. Damage cannot exceed 5 feet, peak smoke optical density not to exceed .50.	IEC 61034-2 Exposed to flame for a maximum of 40 min. Minimum value of 60% light transmittance.

Lapp cables are manufactured to comply with varying degrees of flame resistance requirements. Depending upon your application, certain levels of flame resistance are necessary in order to meet specific end-use requirements. Flammability ratings generally determine the end-use application, which is generally dictated by local or national electrical codes. Certain applications require a minimal amount of flame resistance, such as UL 62 or CSA FT2 for flexible cordage. In this instance, the end use of these products does not deem the necessity of imposing a high flammability requirement. Other applications, such as cables that will be installed permanently within an industrial building, commercial dwelling, or family residence, will most likely require a higher degree of flammability resistance like UL Vertical Tray or CSA FT4. Whatever the end-use application, the Lapp Group meets your requirements with a wide variety of cable products meeting different levels of flame resistance.

*Note: These flame standards are mentioned for purposes of reference only. Some Canadian and European test standards are not necessarily represented here as complete equivalents to the US Standards but have been referenced due to some similarities in requirements. Refer to the individual standards for detailed test procedures and any comparable evaluations.

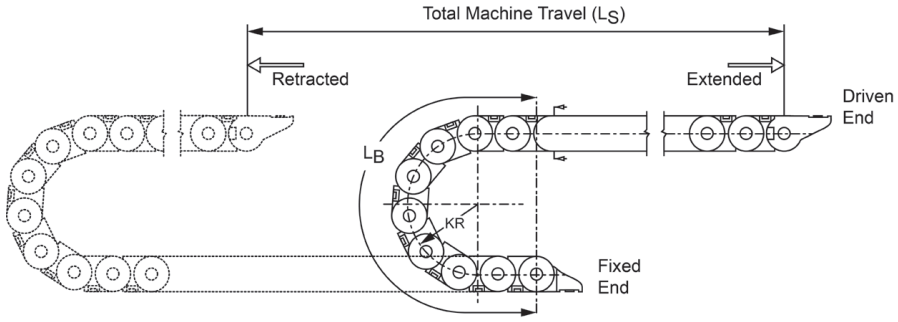
MOTION TYPE

Lapp Terminology	Lapp Definition	Recommended Applications
Stationary	Cables are installed and left in their original position. They are only moved for purposed of maintenance, repair, or retrofitting.	Cable trays, conduits, wire ways installed in buildings, machines, manufacturing facilities, etc.
Flexible 	Cables are moved randomly in a non-automated application. They are susceptible to occasional uncontrolled conditions of movement.	Flexible cable tray routings, machine tools, residential electronics, portable power equipment, etc.
Continuous Flexing 	Cables are in constant linear motion in automated applications. They are subjected to continuous forces applied during bending motions.	Horizontal and vertical c-tracks, power chains, automated assemblies, etc.
Torsion 	Cables are bending and twisting in a x-y-z motion in automated applications. They are subjected to continuous forces applied during torsion motions.	Robot, robot cells, pick-n-place machinery, automotive assembly, etc.

MOTION TYPE

Level	Description	Definition	Cycle Life Range
FL-00	Very Stiff (Static)	Low strand count and difficult to work with, used in static applications	—
FL-01	Flexible	Can be easily installed in machines, conduit, and cable tray when applicable	—
FL-02	Highly Flexible	High flexibility with continuous flexing design attributes	—
WT-01	Wind Turbine Torsion -20°C	Designed for basic wind torsion to an angle of ± 150°/m Application temperature: -20°C	up to 2,000 cycles
WT-02	Wind Turbine Torsion -40°C	Designed for basic wind torsion to an angle of ± 150°/m Application temperature: -40°C	up to 2,000 cycles
WT-03	Wind Turbine Torsion -50°C	Designed for basic wind torsion to an angle of ± 150°/m Application temperature: -50°C	up to 2,000 cycles
CF-01*	Continuous Flexing: Basic	Designed for basic continuous flexing and cable track applications Distance - chain length up to 15 feet	1 - 2 million cycles
CF-02*	Continuous Flexing: Moderate	Designed for continuous flexing and cable track applications Distance - chain length up to 30 feet	2 - 8 million cycles
CF-03*	Continuous Flexing: High	Designed for high cycle continuous flexing and cable track applications Distance - chain length up to 30 feet	8 - 20 million cycles
CF-04*	Continuous Flexing: High-Extended	Designed for high cycle continuous flexing and long cable track applications Distance - chain length up to 300 feet	8 - 20 million cycles
T-01	Torsion	Designed to withstand torsion applications	2 million cycles
TCF-01	Torsion & Continuous Flex	Designed for high cycle continuous flexing and torsion applications	10 million cycles

* When comparing cycle life data between cables, the following critical variables must be evaluated: bend radius, distance, acceleration, speed & weight



L_S = Total Travel Length
L_B = Loop Length
KR = Bend Radius

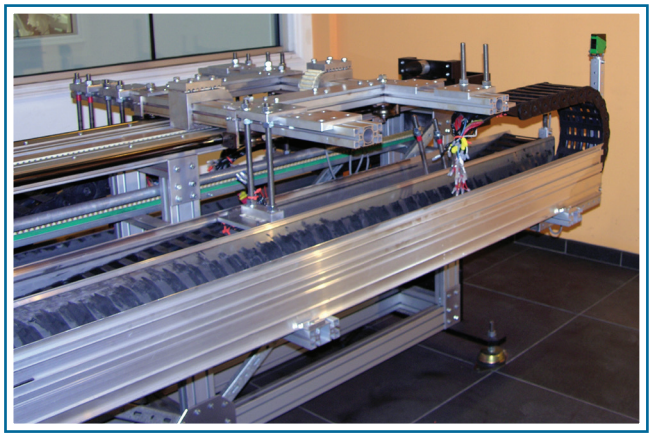
It is important to note that the test variables must be identical, otherwise the comparison is invalid.

The Lapp Group's cable designs are evaluated under the most extreme test conditions. The cycle life testing ranges in the above table do not indicate cable flex cycle failure, but are only indicators of suggested ranges for the intended application. When Lapp continuous flex cables are installed correctly in the application, a longer service life will result. For over half a century, Lapp products have been expertly designed, processed, manufactured, and tested with state-of-the-art equipment, guaranteeing the finest flexible cable products available. Our credibility and expertise have classified Lapp as the "innovator" in the industrial flexible cable and robotic industry.

MOTION TYPE

Test Conditions for Continuous Flex Cables

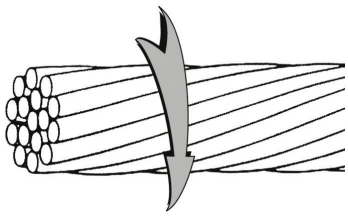
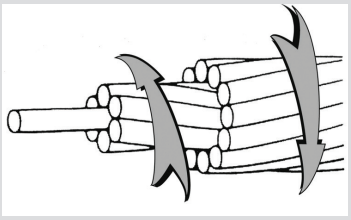
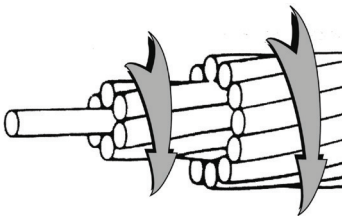
Minimum bend radius range factor	5 - 15 x cable diameter
Bending radius range factor during testing	4 - 12 x cable diameter
Travel distance under test conditions	Varies, 15 - 300 ft
Acceleration under test conditions	Varies, up to 164 ft/s^2
Temperature range during test	-10°C to +22°C
Speed of travel during test	Varies, 6.5 - 16 ft/s

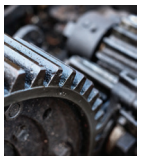


Test Conditions for Torsion Cables

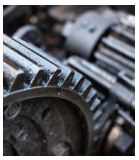
Standard torsion test	± 450°/m
Severe torsion test	± 720°/m
Rotational speed	Varies, up to 5 rpm
Tensile load	Varies, up to 150 lbs

MOTION TYPE

Lapp Design	Lapp Definition	Use
Unilay or Bunch 	Conductors of any number are twisted together with the same lay direction and cable lay length. Bunch construction will not have a well-defined geometric configuration and may have a variable cross-section. A unilay construction will have a well-defined geometric configuration and a defined cross-section.	This type of cabling technique is usually used on stationary designs.
Concentric Contra-Helical 	Conductors are surrounded by well-defined layers of helically laid conductors. Each layer has a reversed lay direction and an increasing lay length in each succeeding layer.	This type of cabling technique is usually used on continuous flex designs.
Concentric Unilay 	Conductors are surrounded by one or more layers of helically-laid conductors with the same direction of lay and increasing lay length in each succeeding layer.	This type of cabling technique is usually used on torsional and continuous flex designs.



MECHANICAL PROTECTION



Level	Description	Impact	Crush	Cold Impact	Cold Bend	Tensile	Elongation	Standard
MP-00	Minimum mechanical resistance protection	–	–	–	–	–	–	–
MP-01	Average	–	*	*	–	1,500 psi	100%	ASTM D-412
MP-02	Good: Independent lab-tested for crush & impact	10/50 lb	1,000/ 2,000 lbf	–	-25°C	1,700 psi	175%	UL 1277 ASTM D-412
MP-03	Very Good: Rated for Exposed Run use (-ER)	10/50 lb	2,500/ 4,200 lbf	-25°C (CSA-TC)	-40°C (UL 62)	2,300 psi	275%	UL 1277 ASTM D-412
MP-04	Very Good: Rated for Exposed Run use (-ER)	10/50 lb	2,500/ 4,200 lbf	-40°C	-55°C***	2,300 psi	275%	UL 1277 ASTM D-412
MP-05	Excellent	**	**	–	–	3,400 psi	325%	ASTM D-1457
MP-06	Superior	**	**	–	–	4,200 psi	500%	ASTM D-412

* Impact and crush tests not applicable for intended end use of product.
** Testing is not required. If tested, these groups would meet or exceed UL 1277 impact and crush requirements by virtue of their superior mechanical properties.
*** Lapp standard.

Note: Lapp mechanical protection test values for each level meet or exceed the requirements of the standards referenced.

Depending upon the specific application, a cable may be exposed to external factors and various types of abuse. The explicit type of industrial manufacturing or processing environment will determine the actual degree of mechanical protection that a cable requires. Such environments include: CNC machine centers, mining, food and beverage plants, automotive assembly lines, machine tools, data processing, and automation applications. The unintentional mishaps that occur every day during routine manufacturing can range from a cable being struck by a falling object, to it being accidentally run over; there are many types of potential mechanical abuse in industrial environments. With all the hazards that your cable may be exposed to, you will need the protection and reliability that is provided in the many design configurations offered by the Lapp Group.