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MOTION CONTROL DIVISION

PRODUCT: CABLES **SUBJECT:** *Flexible and Flexing*

CATEGORY: *Prod. Note*
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SUMMARY: This document is a guide for distinguishing the differences between flexibility and flexing. Additionally information regarding sigma I&II cables is included.

Three Types of Cable Applications:
In regards to cables, servo applications can be classified into three categories; non-flex, moderate-flex and continuos-flex applications. Non-flex applications, are applications where the cable is not moving but may be bent. Moderate flex applications are applications when the cable is occasionally bending. Continuos-flex applications are applications where the cable is in constant motion. The boundaries for moderate flex applications are as wide as they are subjective. If there is any doubt whether a flex application is moderate or continuos flex, choose the latter.

Three types of Cables:
Cables are designed around the type of flex application and environment they are to be used. Cables may meet UL or CE specification or both. The three cable types to meet the above applications are standard/non-flex, moderate-flex/flex and continuos-flex/flexing. Most standard cables are made for non-flex to low moderate flex applications. These types of cables will use paper cable fillers with no lubrication. Shielded standard cables will be braided or have a foil shield. Typically, bend radius and life expectancy estimations are not given for these types of cables.

Most cable manufactures do not offer flex cables for moderate flex applications. Instead they sell either standard cable or continuos flex cables. For the ones that do offer moderate flex, they will use special shielding and insulation techniques to compensate for the higher friction generated by the flexing motion. These types of cables may also increase the number of strands per inch in the wires, which increases its flexibility and helps prevent cork screwing. All these features in effect will decrease friction and increase the cable life. Typical cable life will be in the millions of bends if the minimum bend radius is not exceeded. Life expectancy for standard cables used in moderate flex applications will be less.

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Flexing cables are similar to flex cables but further fiction decreasing design features may be added. Lubrication may be added (chalking powder) to further reduce friction. For shielded cables, an inner jacket may be added between the shield and the inner wires. If standard cable is used in a continuos flex application, the life expectancy will be far less than the continuous flex cable.

Flexible vs. Flexing

A common misconception is that continuos flex cables are also highly flexible; however, this is typically not true. To be flexible, the cable must naturally have a tight bend radius. Due to the continuos flex cable's design, the extra inner jackets needed to reduce friction often makes the continuos flex cables more rigid than standard cables.

Minimum Bend Radius

To determine the flexing properties for a cable, some cable vendors will publish a recommended minimum bend radius for optimal cable life. Typically, this value is a multiple of the cables outer diameter (OD). For example, OLFLEX Cable FD890 has a bend radius of 10OD. If the cables outer diameter is 10mm then the minimum bend radius should not go below 100mm or a diameter of 200mm if the expected life expectancy of 9 million cycles is to be achieved. Making the bend radius greater than the minimum bend radius can increase Cable life. Typically, doubling the cable's bend radius will triple the cable life. For example, OLFLEX's FD 755P has a minimum bend radius of 12O.D. (outer diameter) at 4.4 Million cycles. If at the machine the bend radius is 24O.D. and is in a continuos flex application, the cable life should be about 13.2 million bend cycles.

Other Factors that Effect Cable Life

Some factors that adversely decrease cable life are cable tension, operating speed, temperature, and kinking. To avoid kinking and internal temperature build up due to friction, follow these general rules:

- Cables should be hung suspended for 48 hours to develop its most natural lay
- A cable should be installed with its most natural lay
- Provide strain relief at both end points.
- If possible, install cables in a track to ensure that the minimum bend radius is not exceeded. Distribute the weight evenly by placing heavier cables toward the outside and lighter cables in the middle. Additionally cables should be free to move in the track. Do not wire tie cables together or to the track.

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Specifications for Flexing Cables

When and if a flex cable is flex tested, it typically is placed in a cable track and repeatable flexed slightly under the manufactures anticipated OD rating. The variables of this test are the travel distance, acceleration, temperature and travel speed. Unfortunately, no standard exists to mandate what these variables should be per cable style or cable manufactures. Therefore when comparing flex cable quality, consider the manufactures testing methods.

Due to the cost and time required to test a cable, most continuos flex cables are not tested. When no bend specifications are available, use these general industry standards for determining the OD for you're given application:

	Minimum Bend Radius		
Cable	**Non-Flex**	**Moderate Flex**	**Flexing**
Unshielded	4 x OD	6 x OD	8 x OD
Shielded	4 x OD	8 x OD	12 x OD

Where:
Non-Flex is a fixed installation with no cable motion
Flexing is a cable under constant motion
Moderate Flex is somewhere between Non-Flex and Flexing

Yaskawa Cable Flex Specification

Most continuos flex applications use low horsepower motors. Because of this, Yaskawa's small size motors uses flexing style cables. Conversely, most large size motors are used in non-flex or moderate flex applications. Please see the list below to determine the pre-wired cable style from stock.

Function	Cbl Part# *	Gauge	Style	OD (mm)	Flexing OD in (mm)	Markings
Pwr	JZSP-CMM00-XX(A)	20AWGx4	Flexing	7.75	3 (77.5)	UL*, CSA
Pwr w/ Brk	JZSP-CMM10-XX(A)	20AWGx6	Flexing	9.3	3.66 (93)	UL*, CSA
Pwr	BAHCE-XX(A)	20AWGx4	Flexing	9.14	3.6 (91.4)	UL*, CSA
Pwr w/ Brk	BAHBCE-XX(A)	20AWGx6	Flexing	10.7	4.21 (107)	UL*, CSA
Encoder	JZSP-CMP00-XX(A)	22x2C, 24x2P	Flexing	6.5	3.0 (78)	UL*, CSA
Pwr	B4ICE-XX(A)	20AWGx4	Flexing	9.1	3.6 (91)	UL*, CSA

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Pwr w/ Brk	B4IBCE-XX(A)	20AWGx6	Flexing	10.7	4.21 (107)	UL*, CSA
Pwr	B5ICE-XX(A)	16AWGx4	Flexing	10.8	4.23 (108)	UL*, CSA
Pwr w/ Brk	B5IBCE-XX(A)	16AWGx6	Flexing	12.2	4.8 (122)	UL*, CSA
Encoder	A1ICE-XX(A)	22x2C, 24x2P	Flexing	6.5	3.0 (78)	UL*, CSA
Pwr	B1E-XX(A)	12AWGx4	Standard**	16.4	6.46 (164)	UL*, CSA
Pwr	B2E-XX(A)	10AWGx4	Standard**	17.9	7.05 (179)	UL*, CSA
Pwr	B3E-XX(A)	8AWGx4	Standard**	23.9	9.41 (239)	UL*, CSA
Pwr	B5E-XX(A)	6AWGx4	Standard**	27.4	10.79 (274)	UL*, CSA
Pwr	B6E-XX(A)	4AWGx4	Standard**	32.3	12.72 (323)	UL*, CSA
Pwr w/ Brk	B1BE-XX(A)	12AWGx6	Standard**	18.9	7.44 (189)	UL*, CSA
Pwr w/ Brk	B2BE-XX(A)	10AWGx6	Standard**	20.8	8.19 (208)	UL*, CSA
Pwr w/ Brk	B3BE-XX(A)	8AWGx6	Standard**	23.2	9.13 (232)	UL*, CSA
Brk	B7BCE-XX(A)	16AWGx2	Flexing	8.9	3.5 (890)	UL*, CSA
Pwr	B1CE-XX(A)	12AWGx4	Flexing	14.6	5.75 (146)	UL*, CSA, CE
Pwr	B2CE-XX(A)	10AWGx4	Flexing	15.5	6.10 (155)	UL*, CSA, CE
Pwr	B3CE-XX(A)	8AWGx4	Flexing	19.6	7.72 (196)	UL*, CSA, CE
Pwr	B5CE-XX(A)	6AWGx4	Flexing	28.7	11.3 (287)	UL*, CSA, CE
Pwr	B6CE-XX(A)	4AWGx4	Flexing	33.1	13.03 (331)	UL*, CSA, CE
Pwr w/ Brk	B1BCE-XX(A)	12AWGx6	Flexing	14.7	5.79 (147)	UL*, CSA, CE
Pwr w/ Brk	B2BCE-XX(A)	10AWGx6	Flexing	15.4	6.06 (154)	UL*, CSA, CE
Pwr w/ Brk	B3BCE-XX(A)	8AWGx6	Flexing	19.1	7.52 (191)	UL*, CSA, CE
Pwr	BAE-XX(A)	16AWGx4	Standard**	10.7	4.2 (107)	UL*, CSA
Pwr	BBE-XX(A)	14AWGx4	Standard**	14.6	5.75 (146)	UL*, CSA
Pwr	BDE-XX(A)	10AWGx4	Standard**	17.9	7.05 (179)	UL*, CSA
Pwr	BACE-XX(A)	16AWGx4	Flexing	9.24	3.64 (92.4)	UL*, CSA, CE
Pwr	BBCE-XX(A)	14AWGx4	Flexing	9.88	3.89 (98.8)	UL*, CSA, CE
Pwr	BDCE-XX(A)	10AWGx4	Flexing	15.5	6.1 (155)	UL*, CSA, CE
Encoder	JZSP-CMP01-XX(B)	22x2C, 24x2P	Flexing	6.5	2.56 (65)	UL*, CSA
Encoder	JZSP-CMP02-XX(B)	22x2C, 24x2P	Flexing	6.5	2.56 (65)	UL*, CSA

Notes:

* UL recognized

** It is highly recommended that only Flexing Style cables be used for constant flex applications.
To replace Standard Style cables for Flexing Style, use OLFLEX-FD 890 or equivalent brand.
For example, to replace BAE-XX(A) with a flexing cable use OLFEX-FD 891604; where
89 is the series, 16 is the guage and 04 is the number of conductors.