FG

FLEXION Gripping Solutions

Inspired by the ultimate gripper: the human hand

- Segmented fingers flex to close on parts like a hand
- Configurable design provides for a wide range of gripping solutions

phe

Can be reconfigured and repurposed



ADAPTABLE CONFIGURABLE VERSATILE



Patent Pending





FG01B

Member of the MAC Distributor Network

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Key Features and Benefits

- **PROBLEMS SOLVED** Flexion's distinctly untraditional design solves many challenges that previously had no answer.
- ADAPTIVE DESIGN The unique finger module, similar to a human finger, conforms and adapts to the user's workpiece. When actuated, the internal tendon system engages multiple joints to either encapsulate the part or grip by the fingertips.
- WIDE RANGE OF FORCE The adjustment of the operating pressure allows for a wide range of usable force to provide industrial strength grip for demanding applications or a delicate touch for soft and sensitive product handling.
- CONFIGURABLE SYSTEM Finger modules mount to a gripper hub in either parallel or radial configuration. Finger modules can be mounted in arrays of one to five fingers in each hub position to suit the user's unique requirements. In addition, fingers can be reconfigured by the user as needed to suit multiple purposes.
- DIRECT ROBOT MOUNTING The configured system follows ISO 9409 mounting standards to mount directly to most robots on the market. Pneu-Connect[®] mounting and the URCap software package provide seamless integration with UR robots.
- SENSOR READY Each finger can be equipped with up to two JC1 switches to sense positions such as "part gripped", "missed part", or "starting position."
- ANGULAR ADJUSTMENT Finger modules can be rotated on the hub to spread opposing finger arrays apart or together for optimal workpiece encapsulation.
- CHOICE OF FINGERTIPS A rounded-style tip provides greater grip force while an edged-style tip assists with picking up small items from flat surfaces.

Radial Hub Models

Utilizes 3 finger arrays, ideal for handling circular objects

Parallel Hub Models

Utilizes 2 finger arrays, with up to 5 fingers per array







12 AVAILABLE CONFIGURATIONS: Series FG Flexion

These twelve configurations are currently available assembled. Contact PHD Applications Engineering for more configurations and assistance. Each Flexion configuration can be ordered with optional Grip Plates (-GPx), Robot Mounting Plates (-MTx) and Switch bundles. See the example below. For complete option availability, see the top of page 5.

Flexion Developer Solutions Kits are available, see page 6.

Example: FGCBP - 5 - 20 x 2 -FG410 - FG410 - GPA - MTB - SCNK PARALLEL CONFIGURATIONS FGCBP - 5 - 20 x 2 - FG410 - FG410 FGCBP - 5 - 20 x 2 - FG420 - FG420 FGCBP - 5 - 20 x 2 - FG410 - FG420 - GPx - MTx - Sxxx - GPx - MTx - Sxxx - GPx - MTx - Sxxx FGCBP - 5 - 20 x 2 - FG420 - FG430 FGCBP - 5 - 20 x 2 - FG450 - FG450 FGCBP - 5 - 20 x 2 - FG440 - FG450 - GPx - MTx - Sxxx - GPx - MTx - Sxxx - GPx - MTx - Sxxx FGCBP - 5 - 20 x 2 - FG421 - FG422 FGCBP - 5 - 20 x 2 - FG421 - FG435 FGCBP - 5 - 20 x 2 - FG435 - FG435 - GPx - MTx - Sxxx - GPx - MTx - Sxxx - GPx - MTx - Sxxx FGCFP - 5 - 20 x 2 - FG420 - FG420 **RADIAL CONFIGURATIONS** - GPx - MTx - Sxxx FGCBR - 5 - 20 x 3 - FG410 - FG410 FGCBR - 5 - 20 x 3 - FG420 - FG420 - FG410 - GPx - MTx - Sxxx - FG420 - GPx - MTx - Sxxx

ORDERING DATA/SYSTEM CONFIGURATION: Series FG

TO ORDER SPECIFY:

Product, Action, Finger Array Orientation, Hub, Design No., Size, Number of Finger Arrays, Finger Array Specification Fields, Grip Plate, Robot Mounting Plate, and Switches.



Gray shaded codes are not available at this time. Contact PHD for availability.

CONFIGURING A SYSTEM

For visual assistance with ordering a Flexion Gripper solution





ORDERING DATA/FINGER ARRAY CONFIGURATIONS: Series FG



GO1B

FLEXION DEVELOPER SOLUTIONS KITS

The Developer Solutions Kits contain the parts to build a large variety of combinations, based on the type and size of kit purchased. There are either Parallel or Radial kit types and each have three options for quantity of fingers and related parts. These kits provide the ability to test different gripper configurations with your applications to determine the optimal setup needed.



PARALLEL SOLUTIONS KIT BASE NO. CONTENTS

COMPONENTS	91662-04-014 (Small Kit)	91662-06-014 (Medium Kit)	91662-10-014 (Large Kit)
	QUANTITY	QUANTITY	QUANTITY
Parallel Hub	1	1	1
Clevis (Standard Mount)	2	2	2
Clevis (Reverse Mount)	2	2	2
Finger Module	4	6	10
Spacer, Full Width	6	6	6
Spacer, Half Width	2	2	2
Tierod Assortment Kit	2	2	2
Grip Plate, V-Block	1	1	1
Grip Plate, Convex	1	1	1

Each Flexion Developer Solutions Kit will include all required fasteners and hardware to assemble the complete gripper assemblies.

COMPONENTS	91663-03-014 (Small Kit) QUANTITY	91663-06-014 (Medium Kit) QUANTITY	91663-9-014 (Large Kit) QUANTITY
Radial Hub	1	1	1
Clevis (Standard Mount)	3	3	3
Clevis (Reverse Mount)	3	3	3
Finger Module	3	6	9
Spacer, Full Width	—	3	3
Tierod Kit - 2 Finger Module Positions	—	3	3
Tierod Kit - 3 Finger Module Positions	_	3	3
Grip Plate, Centering Cone	1	1	1

RADIAL SOLUTIONS KIT BASE NO. CONTENTS

Each Flexion Developer Solutions Kit will include all required fasteners and hardware to assemble the complete gripper assemblies.



ENGINEERING DATA: Series FG Flexion

SPECIFICATIONS	IMPERIAL	METRIC	
OPERATING PRESSURE	5 psi* min to 120 psi max	0.4 bar* min to 8.3 bar max	
MAX. OPERATING TEMPERATURE	180°F	82°C	
MIN. OPERATING TEMPERATURE	-20°F	-29°C	
RATED LIFE	5 million cycles		
LUBRICATION	Factory lubricated for rated life		

NOTE: *Unit may not fully articulate at 5 psi [0.4 bar] operating pressure.

AR	FINGE Ticulat	R FULL	VEL	MAXIMUM GRIP FORCE AT		MAXIMUM MINIMUM GRIP FORCE AT GRIP FORCE AT		ARTICULATION TIME AT 87 psi [6 bar]	
LATE Move	ERAL Ment	LONGIT Move	UDINAL Ment	FINGER 5 psi [C	TIP AT (.4 bar]	FINGER 120 psi	TIP AT [8.2 bar]	FULL Flexion	FULL EXTENSION
in	mm	in	mm	lb	N	lb	N		ms
2.20	55.9	2.95	75	1.0	4.4	13.9	62.1	25	130

NOTE: Grip forces assume 0.5 coefficient of friction between finger tip and workpiece.

	WEIGHT		
	OWFONENT	lb	kg
FINGER MODULE	0.45	0.20	
3-CLEVIS RADIAL HUE	3	0.77	0.35
2-CLEVIS PARALLEL H	0.69	0.31	
CLEVIS	0.17	0.08	
CLEVIS LINK	0.26	0.12	
FULL SPACER BLOCK	0.19	0.09	
HALF SPACER BLOCK	0.09	0.04	
TIE-ROD SETS	1.5 FINGER	0.04	0.02
(REQUIRED TO	2 FINGER	0.05	0.02
ASSEMBLE FINGER	3 FINGER	0.07	0.03
GROUPS TOGETHER)	4 FINGER	0.08	0.04

NOTE: Weight values include weights of associated fasteners, but not interconnecting air tubing and fittings.

DETERMINING THE OPTIMAL CONFIGURATION

Contact PHD Applications Engineering or your local PHD distributor partner for assistance with your application. They are trained to assess and deliver the best Flexion solution for your automation process.

Steps to determine the optimal configuration and setup:

- For maximum grip force, grip the workpiece with the finger module's first segment being active and fully articulated (closed), trapping the workpiece against the grip plate. See the graphs on page 8.
- Finger segments 2 and 3 can be utilized as the active segments with reduced force. See the graphs on pages 9 and 10.
- Choose the hub, radial or parallel, that provides the best finger arrangement to match the shape and orientation of your workpiece.
- It is important to choose a grip plate that provides the most contact area and best centers the workpiece.
- Adjust the finger array clevises so that the fingers properly surround the part and articulate at the chosen active segment. See Diagram 1.
- The finger arrays can also be moved to either the high or low mount based on the size and shape of the workpiece.

The grip force graphs on the following pages can be used to estimate the force that each finger can deliver based on which segment is active, the amount of air pressure applied, and the coefficient of friction against the workpiece.







FINGER GRIP FORCE - SEGMENT 1 ACTIVE

Grip force varies with the amount of friction between the finger and workpiece. Graph values below assume that the coefficient of friction listed on each graph applies between the finger and workpiece.

Grip force varies with the amount of finger articulation and the distance between the finger segment pivot and the position of the contact between the segment and workpieces. The diagram to the right illustrates how to determine pivot to segment contact position distance which is used in the appropriate graph below.

Actual grip forces may be higher than those shown depending on the degree that fingers encapsulate the gripped workpiece.

DETERMINING PIVOT TO SEGMENT CONTACT POSITION DISTANCE



Air Pressure 60 to 120 psi [4 to 8 bar]





0.9

1.0 [25.4]

0.7 [17.8]

[15.2]

Pivot to Segment Contact Position Distance in [mm]

0.8

.2 [53] 4 di 10 [44] 5

4 [18]

2 [9]

0.3 [7.6]

0.4 [10.2]

0.5 [12.7]

Total 6 [27]

[25.4]

1.5 [7 1.0 [4

0.5 [2]

0 [0]

0.3 [7.6]

0.4 [10.2]

0.5 [12.7]

0.6 [15.2]

Pivot to Segment Contact Position Distance in [mm]

0.7 [17.8]

0.8

0.9

FINGER GRIP FORCE - SEGMENT 2 ACTIVE

Grip force varies with the amount of friction between the finger and workpiece. Graph values below assume that the coefficient of friction listed on each graph applies between the finger and workpiece.

Grip force varies with the amount of finger articulation and the distance between the finger segment pivot and the position of the contact between the segment and workpieces. The diagram to the right illustrates how to determine pivot to segment contact position distance which is used in the appropriate graph below.

Actual grip forces may be higher than those shown depending on the degree that fingers encapsulate the gripped workpiece.

Air Pressure 5 to 20 psi [0.3 to 1.4 bar]

5 nsi [0.3 bar] No Articulation

- 5 psi [0.3 bar] Full Articulation

DETERMINING PIVOT TO SEGMENT CONTACT POSITION DISTANCE



Air Pressure 60 to 120 psi [4 to 8 bar]



25 [111]



4.0 [18] 3.5 [16 **L** 3.0 [13] **2.5** [11] 2.0 [9] 1.5 [7] 1.0 [4] fotal Grip Force Ib [N] 0.5 [2 0 [0] 0.7 [17.8] 1.5 [38.1] 0.3 [7.6] 0.5 0.9 1.3 [33.0] 1.1 [27.9] Pivot to Segment Contact Position Distance in [mm]





1.3 [33.0]

[27.9]

1.5 [38.1]



With 0.6 Coefficient of Friction Against Workpiece





FINGER GRIP FORCE - SEGMENT 3 ACTIVE

Grip force varies with the amount of friction between the finger and workpiece. Graph values below assume that the coefficient of friction listed on each graph applies between the finger and workpiece.

Grip force varies with the amount of finger articulation and the distance between the finger segment pivot and the position of the contact between the segment and workpieces. The diagram to the right illustrates how to determine pivot to segment contact position distance which is used in the appropriate graph below.

Actual grip forces may be higher than those shown depending on the degree that fingers encapsulate the gripped workpiece.

DETERMINING PIVOT TO SEGMENT CONTACT POSITION DISTANCE

35





FINGER MODULE



FULL FINGER WIDTH SPACER



HALF FINGER WIDTH SPACER







-R THREE-CLEVIS RADIAL HUB





CLEVIS

-P

TWO-CLEVIS PARALLEL HUB





-GPA V-BLOCK (xFGxxP only)







-GPC CONVEX PLATE (xFGxxP only)



All dimensions are reference only unless specifically toleranced.



0

0

-MTA ISO 31.5 mm, 40 mm, 50 mm BOLT CIRCLE



-MTB 56 mm BOLT CIRCLE



-MTC ISO 63 mm, 80 mm BOLT CIRCLE





-MTD PNEU-CONNECT





OPTIONS: Switches



-SC OPTION

PART NO.

JC1SDP-5

JC1SDP-K

JC1SDN-5

JC1SDN-K

PART NO. 63549-02

63549-05

SPECIFICATIONS

OPERATING TEMPERATURE

OPERATING PRINCIPLE

INPUT VOLTAGE

OUTPUT CURRENT

OUTPUT TYPE

VOLTAGE DROP

SWITCH BURDEN

ENVIRONMENTAL

BUNDLED SWITCH OPTIONS

These options conveniently provide switches with additional hardware if required. Series JC1SDx-x single position and inductive proximity switches are available as NPN or PNP. Series JC1STP-x teachable switch is available as PNP only. Connection method may also be specified along with quantity of up to nine switches.

Each Series FG Flexion is sensor ready and has two 4 mm slots for optional JC1 switches for the sensing of finger flex position such as "part gripped", "no part", or "starting position."

All JC1 switches have an LED indicator for convenient setting and troubleshooting. They are rated at IP67 Environmental Protection with a polyurethane (PUR) jacketed cable. Additionally, they feature integrated protection circuitry including short circuit protection, and improved switch hysteresis and magnetic response uniformity.

Cordsets are ordered separately. See below.

cabled (5 meter) or quick connect versions.



The JC1SD Solid State Switches are offered in 10-30 VDC current

interfacing to system controllers. Solid state sensing provides for

DESCRIPTION

PNP (Source), Axial Sensing, 5 meter cable

PNP (Source), Axial Sensing, Quick Connect

NPN (Sink), Axial Sensing, 5 meter cable

NPN (Sink), Axial Sensing, Quick Connect

DESCRIPTION

M8, 3 pin, Straight Female Connector, 2 meter cable

M8, 3 pin, Straight Female Connector, 5 meter cable

JC1xDP-x

PNP (Source)

MATCHING CORDSETS

sinking (NPN) and current sourcing (PNP) versions for simple

longest life and most reliable operation. JC1SD are available in



SWITCH BUNDLE OPTION CODE



JC1ST Teachable Switches feature two programmable outputs. Since each switch provides two outputs, the Flexion features two switch slots providing up to four outputs by using two switches. Offered in 12–30 VDC current sourcing (PNP) version only with integrated protection circuitry including short circuit protection.

PART NO.	DESCRIPTION
JC1STP-2	PNP (Source) Solid State, 12-30 VDC, 2 meter cable
JC1STP-K	PNP (Source) Solid State, 12-30 VDC, Quick Connect

MATCHING CORDSET

PART NO.	DESCRIPTION
81284-1-001	M8, 4 pin, Straight Female Connector, 5 meter cable

SPECIFICATIONS	JC1STP-x
OPERATING PRINCIPLE	Programmable Magnetic Field Characterization
INPUT VOLTAGE	12-30 VDC
NUMBER & TYPE OF OUTPUTS	Two PNP (Source), separately adjustable
OUTPUT CURRENT	100 mA max., Short Circuit Protection
VOLTAGE DROP	≤ 2.2 VDC
SWITCH BURDEN	≤ 15 mA
ENVIRONMENTAL	IP67
OPERATING TEMPERATURE	-20° to 75°C
TYP. DETECTION AREA	0-50 mm

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JC1xDN-x

NPN (Sink)

Solid State Detection of Moving Magnet

10-30 VDC

100 mA max., Short Circuit Protection

≤ 2.5 VDC

≤ 8 mA

IP67

-30° to 80°C

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