

LFX-A Compact 6-Component Force Transducer With Amplifier Instruction Manual

Thank you for purchasing LFX-A Compact 6-Component Force Transducer With Amplifier (hereinafter referred to as the LFX-A). Read carefully this Instruction Manual before using the LFX-A. In addition, please keep this Instruction Manual near at hand to be used when necessary.

1. Symbols Used in The Instruction Manual

Important items that affect safety and instructions relating to LFX-A functions are indicated with symbols specified below. Be sure to read the instructions accompanied by these symbols.



WARNING

Improper operation of the LFX-A may result in death or severe injury of the operator or other person nearby. Be sure to read the instructions accompanied by this symbol.



CAUTION

Improper operation of the LFX-A may result in injury of the operator or other person nearby. Be sure to read the instructions accompanied by this symbol.

CAUTION

Improper handling may result in breakdown or damage to the LFX-A. To ensure correct operation, be sure to read the instructions accompanied by this symbol.

2. Safety Precautions



WARNING

- The LFX-A may break and fall if a load exceeding the rated load is applied. Install safety measures to prevent accidental fall due to overload.
- If the mounting screws are loosened, the LFX-A may fall and cause injury. Be sure to confirm that the mounting screws are securely tightened.



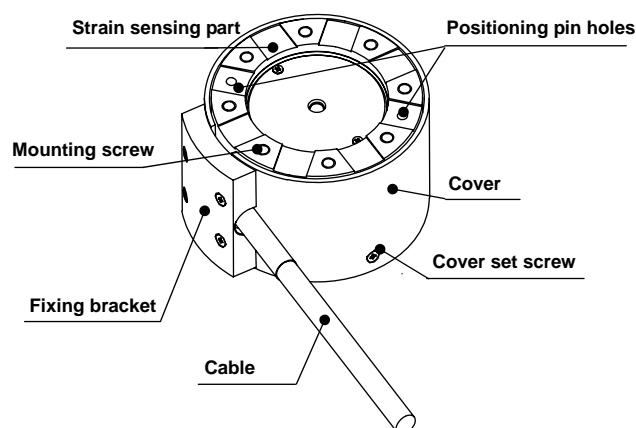
CAUTION

- Be careful not to overload the LFX-A when installing or taking measurement.

CAUTION

- Do not disassemble the LFX-A.
- Avoid dew condensation on the LFX-A.
If condensation is formed on the LFX-A, promptly dry the LFX-A.
- Do not bend the cable near the cable outlet.
- If the LFX-A is used in an environment affected by vibration, fix the LFX-A cable near the fixing bracket to prevent vibration transfer to the LFX-A.
- The LFX-A is not in waterproof or dripproof structure. Do not allow the LFX-A come in contact with water or oil. Also, avoid using the LFX-A in a dusty environment.

3. Parts Names and Principal Functions



(1) Mounting screw holes

Install the LFX-A using the screw holes provided on the top and bottom (P.C.D. 52 mm, 8-M4, depth 5) of the LFX-A.

(2) Positioning pin holes

Two pin holes ($\phi 3H7$) are provided at the same P.C.D. 52-mm positions as screw holes. Use these pin holes to align the centers of the equipment and the LFX-A. Pin holes are provided on the top and bottom of the LFX-A.

Use the accessory parallel pins ($\phi 3g6$ ($\begin{smallmatrix} -0.002 \\ -0.008 \end{smallmatrix}$), length 8) or purchase commercially available parallel pins.

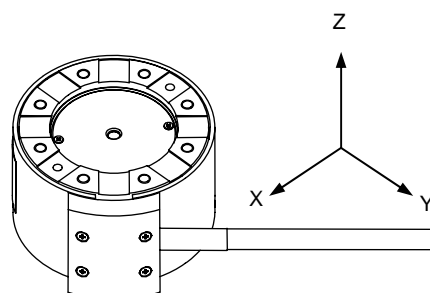
(Equivalent product)

SKFA-GG3-P3.00-L3-B4.5-E0.5-A45 (MISUMI made)

(3) Loading direction

Determine the force detecting direction of the LFX-A by using the positioning pin holes as reference. Connect the 2 pin holes on one side of the LFX-A to provide the X-axis, and specify the fixing bracket side as the positive direction. Consequently, the side where cover set screws are located becomes the negative direction.

* A thru hole ($\phi 4$) in the center can pass the signal line, etc.



4. Installation

4.1 Prior to Installation

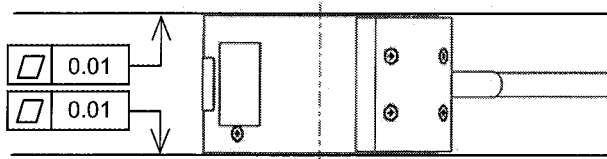
Before installing the LFX-A, take note of the following points.

a. Precautions on overload

Do not apply load exceeding the safe overload on the LFX-A. Applying such an excessive load may cause damage to the LFX-A. If impact load is applied, a force several times larger than the applied load acts upon the LFX-A. Pay due attention and handle the LFX-A with special care during work.

b. Flatness of the mounting surface of the measuring target

Since the LFX-A is installed on the measuring target by means of surface contact, uneven contact surface may affect the characteristics of the LFX-A. To prevent adverse effects on the LFX-A, it is recommended that the flatness of the mounting surface contacted with the LFX-A should be adjusted to 0.01 mm or less with $\phi 64$ mm in outer diameter and $\phi 42$ mm in inner diameter.



c. Mounting accuracy

The LFX-A is designed to detect 6-component force based on the coordinates of 3 reference axes (X, Y and Z-axes). If the LFX-A is not installed by perfectly aligning its coordinates with the coordinates of the measuring target, measured values may have a margin of error. For example, misalignment of 1 degree around the Z-axis generates an interference of approx. 1.7% in component forces FX and FY. Therefore, the LFX-A must be accurately installed in position to ensure accurate measurement.

d. Material of the measuring target

If the material of the measuring target on which the LFX-A is installed is different from the LFX-A, the difference between the linear expansion coefficient of the 2 may change the zero point. At this time, take care to keep the temperature at the time of installation as it is during the measurement.

<Linear expansion coefficient>

LFX-A-3KN: $10.6 \times 10^{-6}/^{\circ}\text{C}$

LFX-A-1KN: $23.6 \times 10^{-6}/^{\circ}\text{C}$

4.2 Installation Method

When installing the LFX-A on the measuring target, use the positioning pin holes to determine the force detecting direction. Check the positional relation between the LFX-A force detecting direction and pin holes.



CAUTION

- When machining the equipment, take special care for the strength of the equipment. If the machine processed equipment does not have sufficient strength, it may break and fall during use or cause unexpected accident.

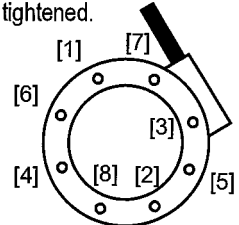
4.3 Screw Tightening

Install 2 parallel pins on each side of the LFX-A and tighten them with 8 hexagonal socket head bolts. If the operating environment is affected by vibration and bolts are likely to loosen, apply commercially available sealant to the bolts. If it is required to reduce the zero drift, apply commercially available adhesive (Recommended: LOCTITE 242) on the mounting surface. Do not allow the adhesive to contact the screw holes.

CAUTION

- If location of the mounting holes are misaligned or the bolts are not inserted vertically, the screw holes of the LFX-A may be damaged.

Tighten the bolts using a torque wrench, etc. The recommended tightening torque is 4.6 N·m for the LFX-A-3KN and 3.0 N·m for the LFX-A-1KN. Do not tighten the bolts with the specified torque in one go, but tighten them in diagonal pairs. Tighten one bolt, then tighten the bolt on the diagonally opposite side, and repeat this 3 times or so until both bolts are securely tightened.



Tighten the bolts in diagonal pairs.

	First tightening	Second tightening	Tightening torque
LFX-A-1KN	1.0 N·m	2.5 N·m	3.0 N·m
LFX-A-3KN	2.0 N·m	4.0 N·m	4.6 N·m

CAUTION

- Be sure to observe the specified tightening torque. If the tightening torque is smaller than the specified torque, the measurement accuracy of the LFX-A may be decreased or the mounting screws may become loose during use. On the other hand, applying excessive tightening torque may damage the threads of the LFX-A and render it unusable.

5. Cable Connection

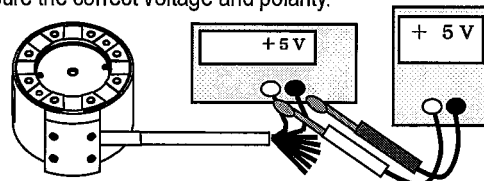
Connect the LFX-A cable to the measuring device.

Signal Name	Wire Color	Symbol
FX	Orange	Red
FY	Gray	Red
FZ	White	Red
MX	Orange	Black
MY	Gray	Black
MZ	White	Black
COM	Blue	
Power Supply +	Red	
Power Supply -	Black	
Shield		

CAUTION

- Before connecting the power cable, make sure that correct voltage and polarity is supplied. Do not apply excessive or reverse voltage. Or, the LFX-A may be damaged.

Ensure the correct voltage and polarity.



(Note) The LFX-A is not provided with protection mechanism against excessive or reverse voltage

- Power supply variation should be within 5 VDC $\pm 10\%$.
- Avoid applying surge voltage to the LFX-A.

6. Output/Conversion

The LFX-A outputs 6-components force of VFX to VFZ and VMX to VMZ. Conduct measurement by taking special care of the excitation voltage.

Next, interference correction is made. The calculated outputs of the 6-component forces are converted with a calibration constant matrix into physical values of 6-component forces (loads FX, FY and FZ and moments MX, MY and MZ).

$$\begin{pmatrix} FX \\ FY \\ FZ \\ MX \\ MY \\ MZ \end{pmatrix} = \begin{pmatrix} \text{Calibration} \\ \text{constant matrix} \\ 6 \times 6 \text{ matrix} \end{pmatrix} \begin{pmatrix} VFX \\ VFY \\ VFZ \\ VMX \\ VMY \\ VMZ \end{pmatrix}$$

The accessory CD-ROM contains calibration constant matrix data as well as an Excel file for simplified output conversion designed to convert outputs from the LFX—A into loads/moments (This file is created using Microsoft Corporation's Microsoft Excel).

7. How to Use Excel File for Simplified Output Conversion

This Excel file is used to calculate physical values from strain outputs of the LFX-A. By entering strain outputs of 6 components, physical values of 6-component forces can be obtained through calculations. See the following steps to use this file.

(1) Input a calibration constant matrix.

Input a calibration constant matrix in the "Calibration Constant Matrix" sheet. The calibration constant matrix of the LFX-A is written in the accessory CD-ROM in advance.

Calibration constant matrix						
	aFx	aFy	aFz	aMx	aMy	aMz
Fx	1.923451	0.032578	-0.026005	-0.069991	0.671844	0.008202
Fy	-0.008850	1.922986	0.014656	-0.664085	-0.064308	-0.003809
Fz	-0.014718	-0.020907	1.996539	-0.006912	0.022753	0.032054
Mx	-0.001146	0.007320	0.000113	0.064143	0.000364	0.000084
My	-0.007424	-0.000769	0.000070	0.000101	0.064060	0.000151
Mz	0.000430	-0.000417	0.000691	0.001411	-0.000636	0.033556

Model	LFX-A-3K
Ser.	123456789
Amp. Ser.	987654321

(2) Convert into physical values

Enter the output voltage (Unit: mV) at no load and the desired data of the LFX-A outputs you want to convert in the "Data Conversion Software" sheet. And then, click the **Execute of Conversion** button.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Data Conversion Software						Model	LFX-A-3K	Execute of Conversion			
2	Initial Value						Ser.	123456789	Clear ALL			
3							Amp. Ser.	987654321				
4	Volt	Fx	Fy	Fz	Mx	My	Mz	2500	Conversion Result			
5		2500	2500	2500	2500	2500	2500	2500	Component Fx Fy Fz			
6	Output Data Value											
7	CH	Fx	Fy	Fz	Mx	My	Mz		Unit	N	N	N
8	Unit	mV	mV	mV	mV	mV	mV					
9		2500	2500	2500	2500	2500	2500	2500	Insert data here.			
10												
11												
12												
13												

The converted physical values are displayed.

(Reference)

If the Excel file for simplified output conversion does not function properly, change the security setting in Excel as follows:

Tools → **Options** → **Security** → **Macro Security** → Low

(Excel data display)

If your PC is not provided with Japanese font function, Excel data is garbled. Considering the users not to become troubled, Excel data in the Instruction Manual is translated purposely into English.

8. Precautions for Storage and Inspection

If the indicated value is unstable or abnormal, check the LFX-A is correctly and securely connected to the measuring device, and also check the LFX-A is used according to the specified instructions. If no abnormality was found, check the following items on the LFX-A.

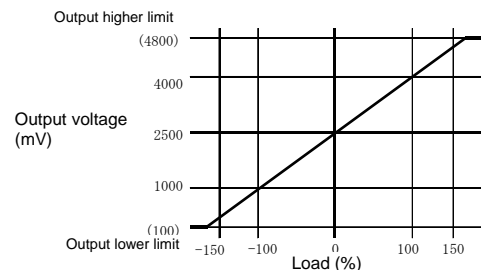
- (1) Loosen the mounting screws and check the output is around 2500mV in no-load state.
- (2) Check insulation resistance between the LFX-A mainbody and any cable conductor wires except the shield wire with a tester, etc. Do not use a Megger for the measurement.
The insulation resistance should be 100 MΩ or more (Measurement voltage: 50 V or less).

If any of the above measured value is abnormal, contact KYOWA or our representative.

9. Specifications

- (1) Weight: LFX-A-1KN Approx. 210 g (LFX-A body only)
LFX-A-3KN Approx. 420 g (LFX-A body only)
- (2) Output voltage at no-load
2500 mV as a standard (See the following figure.)

Output voltages of the 6-component forces (Power supply voltage: 5.0 V)



- (3) Rated capacity (See the next page.)
- (4) Safe overload: 150%
- (5) Nonlinearity: Within ±0.5% RO *
- (6) Hysteresis: Within ±0.5% RO *
- (7) Interference: 1.5% RO or less *
- (8) Frequency response: DC to 500 Hz (+1 dB to -3 dB)
- (9) Power supply: 5 VDC ±10%, Consumption current: 160 mA
- (10) Temperature compensation range:
0 to +60°C (Non-condensing)

- (11) Safe temperature range: -10 to +70°C (Non-condensing)
- (12) Temperature effect on zero balance: Within ±0.05% RO/°C
- (13) Temperature effect on output: Within ±0.05%/°C
- (14) Protection code: IP40 (Not to be wetted)
- (15) Cable: 0.11mm², 16-paired twisted shield cable,
Cable length: Approx. 55 cm, Outer diameter: 6.6 mm,
Bare at the end (9 conductors)

*1: Items (5) to (7) indicate characteristic values after interference correction.

* To obtain rated output of ±1500 mV for the entire 6-component forces from the current mounting state, set zero variation including load, etc. due to tightening and mounting to be within ±200 mV.

* The above characteristics values are measured and obtained using KYOWA's calibrator under KYOWA's standard conditions.

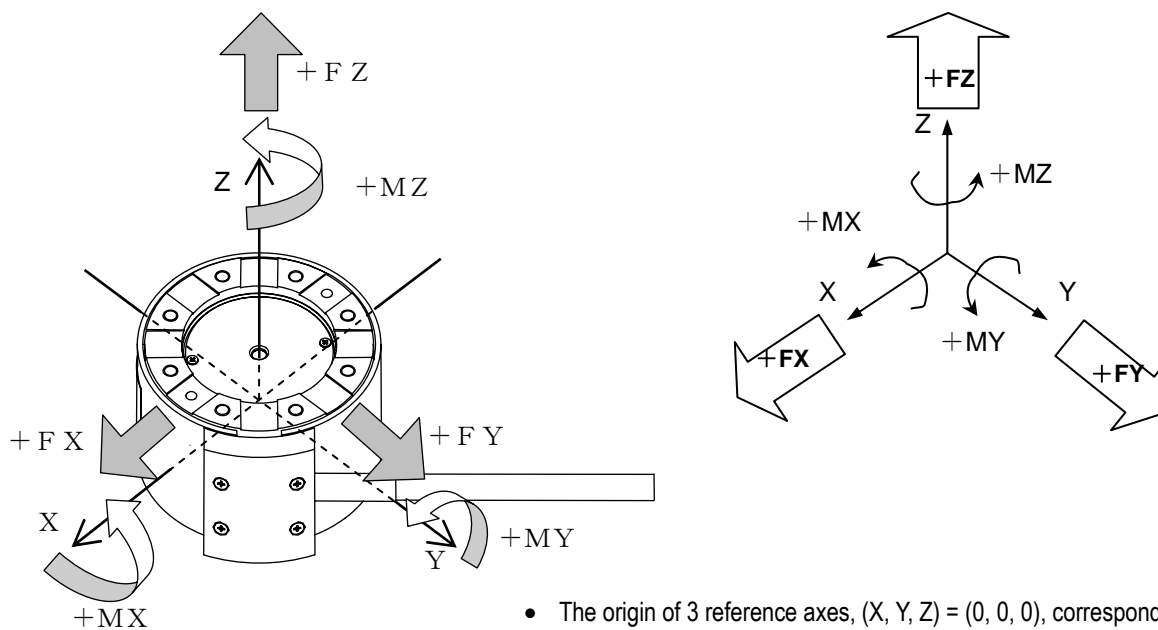
●Accessories Included in the Package

Test data sheet	1
Warranty	1
Instruction Manual	1
CD-ROM	1
Parallel pins	4 (ø3 g6, length 8)
Loading direction label	2

● Rated Capacity, Rated Output, Natural Frequency

Model	Top: Rated capacity, Bottom: Rated output			Frequency response
	FX, FY, and FZ	MX and MY	MZ	
LFX-A-1KN	1 kN	40 N•m	25 N•m	500 Hz
	Approx. ±1500 mV (With output voltage at no load as reference)			
LFX-A-3KN	3 kN	100 N•m	50 N•m	500 Hz
	Approx. ±1500 mV (With output voltage at no load as reference)			

10. Load Directions and Outputs



- The origin of 3 reference axes, (X, Y, Z) = (0, 0, 0), corresponds to the center of the LFX-A.
- The above are load directions applied when the bottom side of the LFX-A (where cover set screws are located) is fixed.

11. Outside View

