Magnescale
SPEED X PRECISION

LH71/72

Segmented error compensation function

Setting manual

1. First of all

This function defines the section within the movable range of the measuring unit and corrects the mechanical error for each section. Since the compensation value is calculated from the reference point, it is valid only when using the measurement unit with built-in reference point scale. The range that can correct the segmented error is the range of 7 digits (display resolution) that is displayed based on the reference point (0) of each axis.
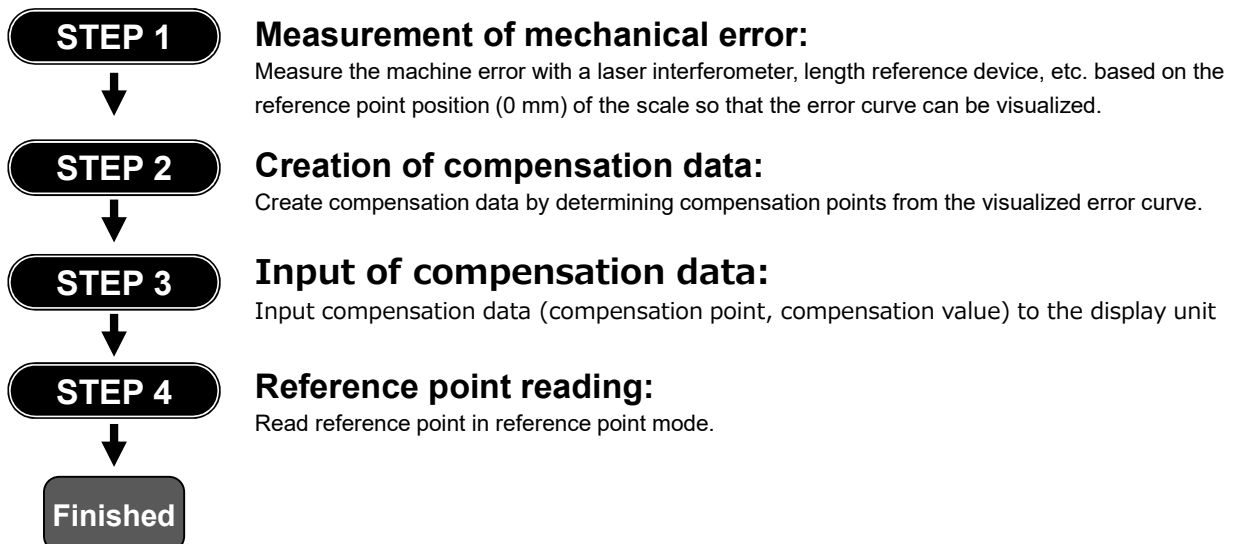
In order to use this function, it is necessary to measure the error between the movement of the machine and the actual movement (detection amount of the measuring unit) with a laser interferometer or the like in advance. Then, determine the compensation value for the segmented error from the measurement result, and input the compensation value to the display unit.

After completing the input of the compensation value, perform the reference point reading operation to enable the interval error compensation. Depending on the tendency of the measured mechanical error, the linear compensation function may be sufficient, so please judge.

NOTE:

- When the segmented error function is set, the reference point reading mode is automatically entered when the detailed settings are completed / when the power is turned on / when the error is cleared.

- The compensation value is zero in the area that exceeds the segmented error compensation (the area that exceeds the set range, the range that cannot be set).

- If the display overflows, the compensation value data will be invalid.

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2. Setting flow of Segmented error compensation function

STEP 1 **Measurement of mechanical error:**
Measure the machine error with a laser interferometer, length reference device, etc. based on the reference point position (0 mm) of the scale so that the error curve can be visualized.

STEP 2 **Creation of compensation data:**
Create compensation data by determining compensation points from the visualized error curve.

STEP 3 **Input of compensation data:**
Input compensation data (compensation point, compensation value) to the display unit

STEP 4 **Reference point reading:**
Read reference point in reference point mode.
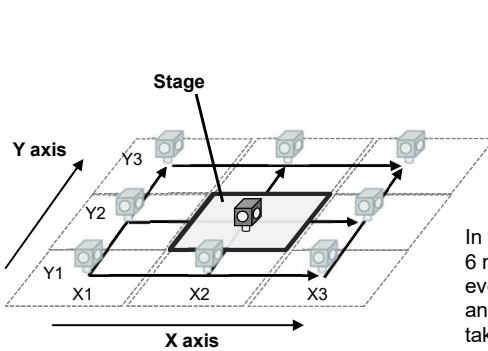
Finished

3. Setting of segmented error compensation function

To use the segmented error compensation function, it is necessary to measure the amount of error with the distance actually traveled with respect to the count value of the measuring unit. To measure the actual distance traveled, use a laser interferometer or the like. The segmented error function can be used in combination with the scale with built in reference point. The base point for the segmented error compensation is based on the reference point position of the scale (0 mm).

The range of segmented error compensation depends on the minimum resolution used. In addition, the maximum number of points that can be corrected for section error is 32 points excluding the reference point. The maximum total compensation amount is ± 600um. The count value of the measuring unit with respect to the actual distance traveled is affected by the direction of movement of the table and the change in attitude of the machine due to the movement of the stage.
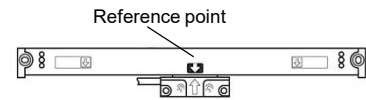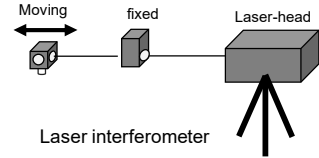
Laser interferometer

	X
Y1	Data1
Y2	Data2
Y3	data3

	X1	X2	X3
Y	data4	data5	data6

Reference point

Measurement unit with built in reference point

Drive range matrix on the X-Y axis plane

In the case of X and Y axes, 6 measurements are required, even if at least the left, right, and center of each axis are taken into consideration.

The measurement range that can correct the segmented error compensation is the range of 7 digits displayed.

| Resolution	Correctable range	Compensation points
0.1um	±999.9999 mm (App. ±1m)	Up to 32 points (Excluding reference points)
0.5um	±999.9995 mm (App. ±1m)	
1.0um	±9999.999 mm (App. ±10m)	
10um	±99999.99 mm (App. ±100m)	

STEP 1 — Measurement of mechanical error

Actually move the stage (or object) and collect the entire error data. Create an error curve from the data and narrow down the changing points (compensation points) to 32 points or less. If there are two or more axes, consider using the average value for each axis or narrowing down to the data of frequently used positions.
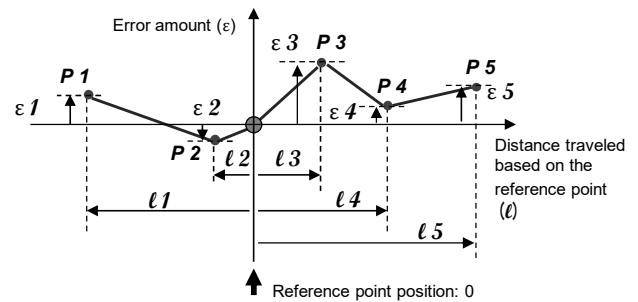
A finer error curve can be obtained by making the sampling interval for acquiring error data finer.
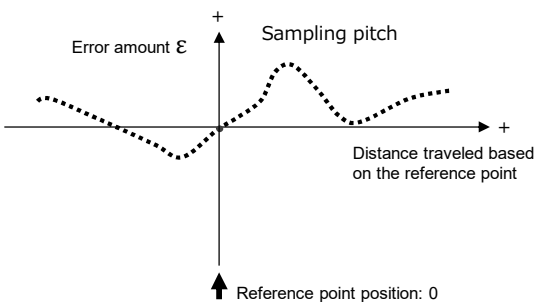
Measured error curve

Narrow down the changing points of the error curve to 32 points or less. Number from 1 in order from the minus side or the smallest value.
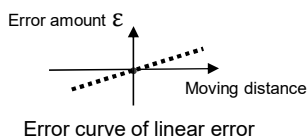(Excluding the reference point position)

Changing points	Distance	Error amount
P1	$\ell 1$	$\varepsilon 1$
P2	$\ell 2$	$\varepsilon 2$
P3	$\ell 3$	$\varepsilon 3$
P4	$\ell 4$	$\varepsilon 4$
P5	$\ell 5$	$\varepsilon 5$

When the changing point is 5 points

If the slope of the error curve is a straight curve, the linear error compensation function may be sufficient instead of the segmented error compensation function.

Error curve of linear error

Error amount : $\varepsilon = \varepsilon\mathcal{M} - \varepsilon\mathcal{C}$

$\varepsilon\mathcal{M}$: Master (laser interferometer, etc.)

$\varepsilon\mathcal{C}$: Count value of display unit

Create compensation data for the changing points narrowed down to 32 points or less from the error curve measured in **step 1.**

* Since the reference point position is 0, it is not included in the compensation points.

Number the changing point in order from the smallest (or minus) side of the count value of the measurement unit. If the start position of the segmented error compensation is position 1 and the end position is position N, the position N should be 32 or less.

The maximum compensation value for the entire changing point is within ± 600μm. If it exceeds the ± 600μm range, the segmented error compensation function cannot be used.

NOTE:

- The segmented error compensation function is applied to the range from the start position (ε 1) to the end position (ε n).
- Input compensation data cannot be handled below the unit of input resolution of the measurement unit.

Number the changing point in order from the smallest (or minus) side of the count value of the measurement unit.
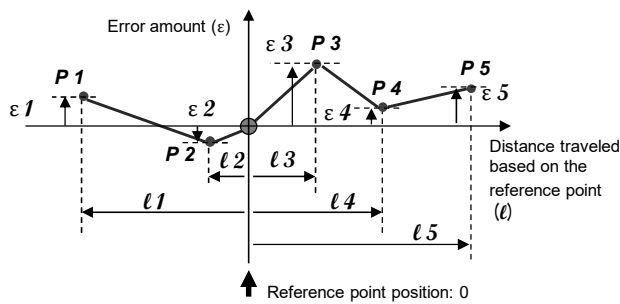
Changing point:
   - Point where the slope of the error curve changes
   - Point where the inclination is reversed

Number of points that can be input: up to 32 points

Compensation amount: up to ± 600μm

When the changing point is 5 points

Error curve compensation data for the above 5 changing points   (Unit: mm)

Compensation point (P)	**P1**	**P2**	Reference point position	**P3**	**P4**	**P5**
Count value of counter unit(ℓ)	-500.0000	-125.000	0.000	200.000	414.000	700.000
Lase display value	-499.9860	-125.008	0.0000	200.032	414.008	700.020
Compensation amount(ε)	0.014	-0.008	0.0000	0.032	0.008	0.020

Compensation amount at compensation point

Position data of compensation point

Compensation point input number

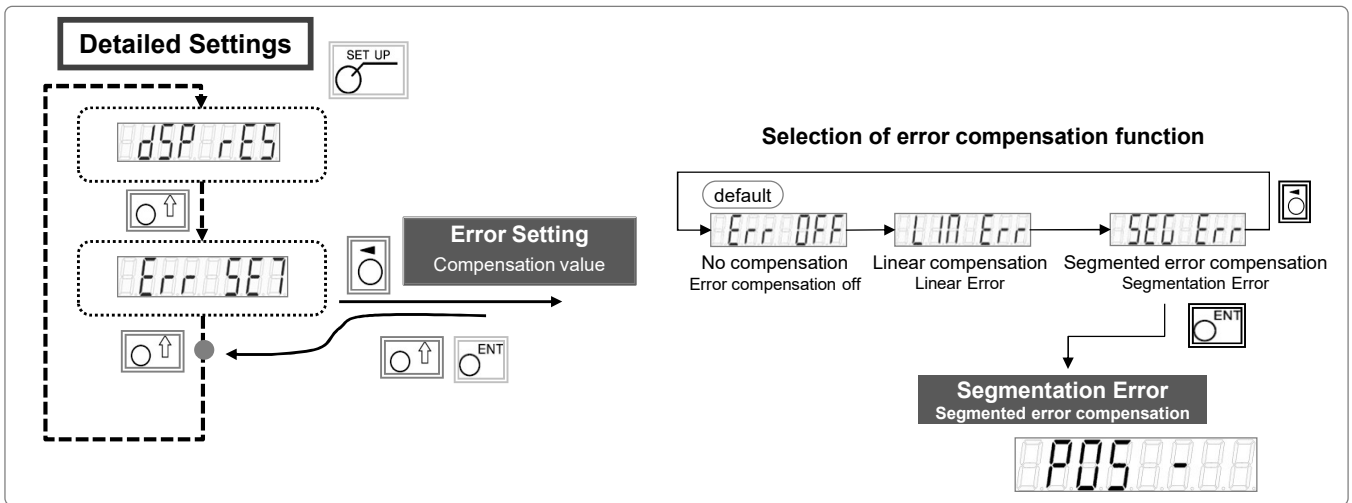**STEP 3** **Input of compensation data**

Enter the compensation data created in **step 2** into the display unit.

① With the display unit in the normal counting state, press `SET UP` key to enter the advanced setting mode.

The display will be `dSP rES` .

② Press `O⇧` key to display the input of the error compensation function. `Err SET`

Press `◀O` key to select `SEG Err` (Segmented error compensation) and press `O ENT` key `POS -`

Detailed Settings `SET UP`

`dSP rES`

`O⇧`

`Err SET`

`◀O`

Error Setting
Compensation value

`O⇧` `O ENT`

Selection of error compensation function

(default)
`Err OFF` → `LIN Err` → `SEG Err` `◀O`

No compensation | Linear compensation | Segmented error compensation
Error compensation off | Linear Error | Segmentation Error

`O ENT`

Segmentation Error
Segmented error compensation

`POS -`

③ When you press `◀O` key of the axis to enter the compensation value, the input display is displayed.

(Position 1)
`POS 1` → `_____`

Enter the position data for the position number with the numeric keys.→ `- 190000`
(Example: -190.000)

Press `O ENT` key to save the position information.

④ Next, the input display of the compensation value is displayed.

Enter the compensation value with the numeric keys `0.000` → `0.007` → `POS 2`
(Example : 0.007)
Automatically moves
to the next input point

Press the `O ENT` key to save the compensation value.

⑤ Repeat ③ and ④ and enter all the required position data and compensation values.

Press `O ENT` key again to finish entering the axis. You can also select it with `O ENT` key when you want to reset it.

Press `RESET` key to exit the detailed setting mode

and enter the reference point mode to enable the segmented error compensation function.

STEP 4   # Reference point reading

Continued from **step 3**

It is necessary to always detect the reference point in order to enable the segmented error compensation function.

* Segmented error compensation is calculated based on the reference point of the measurement unit .

⑥ Press [RESET] key when the power is turned on or after setting the interval error compensation value to enter the reference point acquisition mode.

[REF] key lamp is lit, the axis label lamp is blinking, and the display is [rEF] .

⑦ When you press [◄] key of the axis to get the reference point, the display and the axis label blink.

You can also acquire the reference point of two or more axes at the same time.
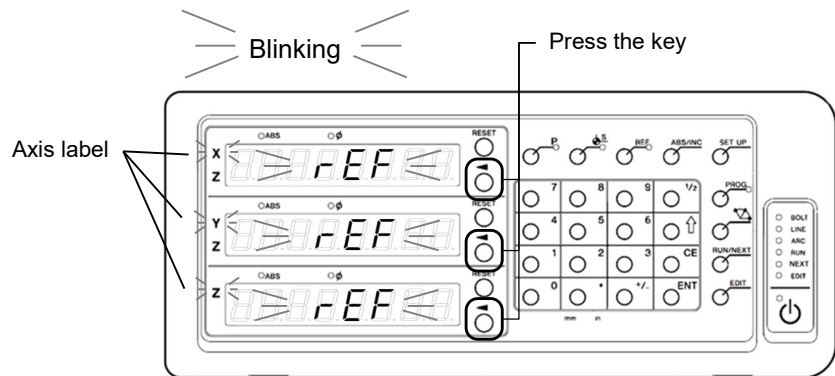
LH71A-3, XYZ axis refrence point acquisition

NOTE: When using the measurement unit for unidirectional reference point detection, move the measurement unit in the direction opposite to the direction in which the reference point is passed. (Not required for bidirectional detection)

⑧ Move the measuring unit to pass the reference point.

The display changes from blinking to lit, and reference point acquisition is completed.

Finished

Reference point