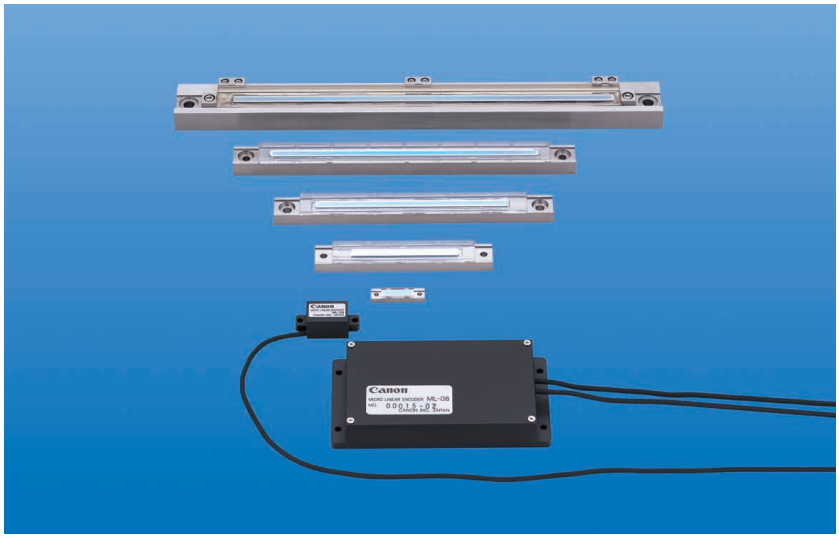
MICRO LINEAR ENCODER



By originally pioneering "light reflection-diffraction interference method," We were able to achieved ultra-compact size and high linear precision with micro linear encoders.

The Canon Micro Linear Encoder ML Series uses LED as its light source and is equipped with the optimum optical technology. It is not a traditional encoder; rather, it is a linear encoder of the next generation with super-high precision and ultra-compact size. Combined with an interpolator, it is capable of achieving a high resolution of 0.8nm.

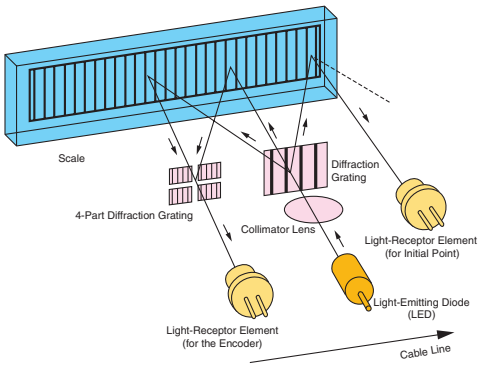
THEORY

As shown in the figure, the light beams emitted by an LED are made into parallel light beams by a collimator lens, separated into three optical beams (orders 0, +1, and -1), and are irradiated to a scale. Two of these optical beams (diffracted beams of orders 0 and -1) are used for the encoder while the other beam (diffracted beam of order 1) is used for the initial point.

The theory behind encoder measurement is as follows: first, the diffracted beam of order 0 and the diffracted beam of order 1 are irradiated to the scale placed opposite from the head, as shown in the figure. The diffracted beams of orders +1 and -1 generated here are composed by a diffraction grating (on the head side) divided into 4 parts and then injected into a light-receptor element.

The optical beams diffracted by the scale here have the property that their phase slides by $\pm 2\pi$ when the scale slides by one pitch. As a result, if the scale moves by one pitch at the light-receptor element, two sinusoidal-curve signals are obtained; further, because the grating that composes the light beams is divided into 4 parts, each with a 1/2 pitch interval, four signals are sent with a phase difference of 90 degrees. The ML-08 type has a scale pitch of 1.6µm and sends output signals with a period of 0.8µm from the head; the ML-16 type has a scale pitch of 3.2µm and sends output signals with a period of 1.6µm from the head.

The theory of initial-point measurement functions as follows. Light beams are diffracted on the initial-point sensor side with respect to the light source. These beams do not enter the light-receptor element when an end of the scale is reached but rather follows the light path shown with the dotted line in the figure. The output from the light-receptor element becomes small as a result, and this helps detect the initial point.



FEATURES

- Our optimum optical system detects the interference of reflected and diffracted beams, alignment and adjustment are easier than on a permeable type.
- The use of a scale makes our unit more stable with respect to changes in the ambient environment conditions when compared with the traditional laser interference length-measuring instruments that use laser wavelengths as the standard for measurement.
- Since an LED is used as the light source, the expected life is significantly improved over the type that uses semiconductor laser.
- Our relay box contains an electrically partitioned HIC in its interior, making the system more compact.

APPLICATION EXAMPLES

- Sensor for Linear Motor Stages
- Hard Disc Detectors
- Semiconductor Measuring Instruments
- Three-Dimensional Measuring Instruments

SPECIFICATIONS TABLE

		ML-08		ML-08/80		ML-08/1000GA		ML-16		ML-16/80		ML-16/1000GA	
		Resolution	Max. Freq.*2	Resolution	Max. Freq.	Resolution	Max. Freq.*1	Resolution	Max. Freq.*2	Resolution	Max. Freq.	Resolution	Max. Freq.*1
Interpolation Rate	–	0.8μm	300kHz					1.6μm	480kHz				
	20			40nm	200kHz					80nm	200kHz		
	40			20nm	200kHz					40nm	200kHz		
	80			10nm	100kHz					20nm	100kHz		
	100					8.0nm	100kHz					16.0nm	100kHz
	125					6.4nm	100kHz					12.8nm	100kHz
	200					4.0nm	86kHz					8.0nm	86kHz
	250					3.2nm	68kHz					6.4nm	68kHz
	400					2.0nm	43kHz					4.0nm	43kHz
	500					1.6nm	34kHz					3.2nm	34kHz
	800					1.0nm	21kHz					2.0nm	21kHz
	1000					0.8nm	17kHz					1.6nm	17kHz
Scale Grating pitch		1.6μm						3.2μm					
Scale Linearity*3 & Material	10mm	± 0.08μm, QUARTZ						± 0.09μm, QUARTZ					
	50mm	± 0.2μm, QUARTZ						± 0.2μm, NEOCERAM					
	100mm	± 0.3μm, QUARTZ						± 0.3μm, NEOCERAM					

*1 The counter's responce frequency should be 20Mbps.

*2 When the rectangle wave signal is used.

*3 Comparison measurement with proofreaded Laser Interferometer at 23˚C.

ML-08
ML-16

LED light-diffraction interference method realize sub-micron resolution

SPECIFICATIONS

■Output Signal

●A phase B phase

Resolution	ML-08 : 0.8μm
	ML-16 : 1.6μm
	(when the pulse edge is counted)
Signal type	Sinusoidal differential (from CN2)
	Sinusoidal single end (from CN3)
	Rectangle differential line driver (from CN4)

●Z phase pulse

pulse width	100±20μsec
Signal type	Differential Line Driver
Output timming	1 pulse output at the right end of the scale as seen from the head sides.
Repeatability	ML-08 : ± 0.8μm or less
	ML-16 : ± 1.0μm or less

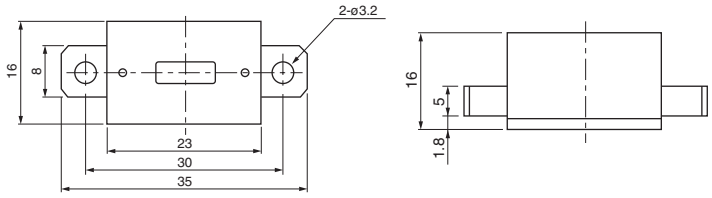
■Maximum response speed	ML-08 : 240mm/sec
	ML-16 : 480mm/sec
■Power supply voltage	DC + 5.00V ± 5%
■Operating temperature	10 to 40˚C
■Storage temperature	-10 to 50˚C
■Humidity	80%RH or less (no condensation)
■Vibration	10G, 500Hz max.
■Shock	60G, 11ms max.

OUTPUT SIGNAL

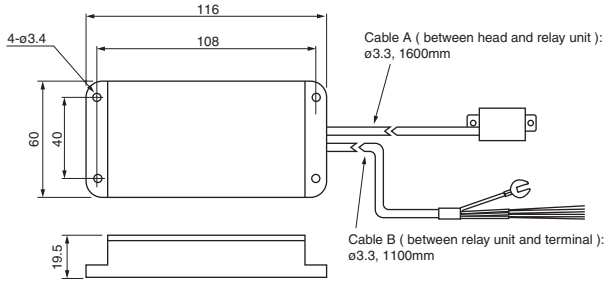
	A/B phase signal output type	Sine wave output (differential)	Sine wave output (single end)	Rectangle wave output (differential line driver)
No.	Cord color	Relay unit CN2	Relay unit CN3	Relay unit CN4
1	Red	A+ phase sine wave	A+ phase sine wave	A+ phase rectangle wave
2	White	A- phase sine wave	GND	A- phase rectangle wave
3	Orange	B+ phase sine wave	B+ phase sine wave	B+ phase rectangle wave
4	Blue	B- phase sine wave	GND	B- phase rectangle wave
5	Yellow	Z+ phase pulse	Z+ phase pulse	Z+ phase pulse
6	Green	Z- phase pulse	Z- phase pulse	Z- phase pulse
7	Pink	+5V	+5V	+5V
8	Gray	+5V	+5V	+5V
9	Brown	0V (GND)	0V (GND)	0V (GND)
10	Black	0V (GND)	0V (GND)	0V (GND)
Shield		Frame ground (case)		

EXTERNAL DIMENSIONS

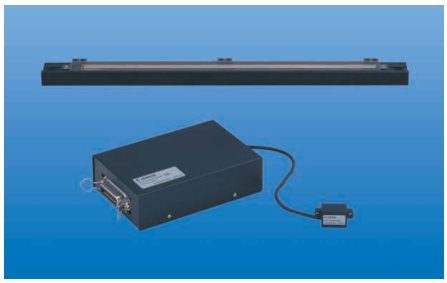
●Head



●Relay unit



ML-08/80
ML-16/80



Compact and low cost 80-fold Hybrid IC interpolator included

SPECIFICATIONS

■Output Signal
- ●A phase B phase
  - Signal Resolution: ML-08/80 : 0.01μm; ML-16/80 : 0.02μm (when the pulse edge is counted)
  - Waveform: Rectangle signal (Interpolated and before Interpolation)
  - Signal type: Differential Line Driver
- ●Z phase pulse
  - pulse width: 100± 20μsec
  - Signal type: Differential Line Driver
  - Output timming: 1 pulse output at the right end of the scale as seen from the head sides.
  - Repeatability: ML-08 : ± 0.8μm or less; ML-16 : ± 1.0μm or less

■Maximum response speed: ML-08/80 : 80 to 160mm/sec; ML-16/80 : 160 to 320mm/sec

■Power supply voltage: DC + 5.00V ± 5%

■Operating temperature: 10 to 40˚C

■Storage temperature: -10 to 50˚C

■Humidity: 80%RH or less (no condensation)

■Vibration: 10G, 500Hz max.

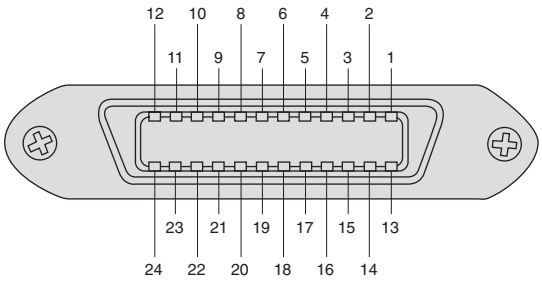
■Shock: 60G, 11ms max.

OUTPUT SIGNAL

●Output Connector pin number and function

Interpolated signal is output from the output connector (DDK:57FE-40240-20S or compatible)

Each signal type are all differential line driver.

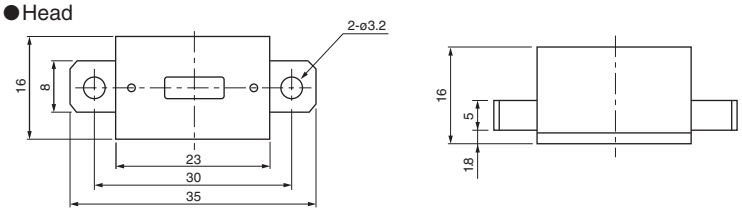


No.	Function	No.	Function	Remark
1	PCA+	13	PCA-	Two phase rectangle signal after interpolation
2	PCB+	14	PCB-	
3	PCZ+	15	PCZ-	Z phase pulse
4	GND	16	GND	Signal ground
5	NC	17	NC	No connection
6	NC	18	NC	
7	GND	19	GND	Signal ground
8	pca+	20	pca-	Two phase rectangle signal before interpolation
9	pcb+	21	pcb-	
10	NC	22	NC	No connection
11	+5V	23	+5V	Power
12	NC	24	NC	No connection

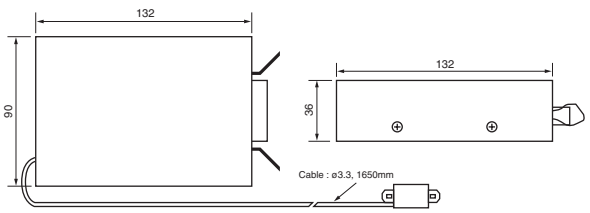
*Please use all +5V and GND terminal as possible in order to reduce the power impedance.

EXTERNAL DIMENSIONS

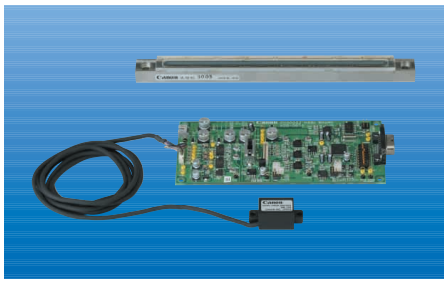
●Head



●Interpolator



ML-08/1000GA
ML-16/1000GA



Achieved high resolution of 0.8nm, combined with CI-1000GA interpolator

SPECIFICATIONS

■Output Signal

●A phase B phase

Signal Resolution	ML-08/1000 : 0.8nm ML-16/1000 : 1.6nm (when the pulse edge is counted)
Waveform	Rectangle signal (Interpolated)
Signal type	Differential Line Driver

●UP/DOWN Pulse

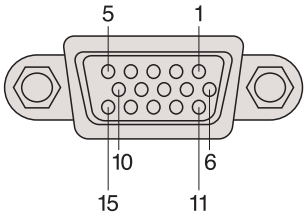
Signal Resolution	ML-08/1000 : 0.8nm ML-16/1000 : 1.6nm
pulse width	25 ns to 3.2 μs (1/2 of interval setting time)

●Z phase

pulse width	200 ± 60μsec
Signal type	Differential Line Driver
Output timming	1 pulse output at the right end of the scale as seen from the head sides.
Repeatability	± 0.8μm or less

■Maximum response speed	ML-08/1000 : 13.6 to 80mm/sec ML-16/1000 : 27.2 to 160mm/sec
■Power supply voltage	DC + 5.00V ± 5%
■Operating temperature	10 to 40˚C
■Storage temperature	-10 to 50˚C
■Humidity	80%RH or less (no condensation)
■Vibration	10G, 500Hz max.
■Shock	60G, 11ms max.

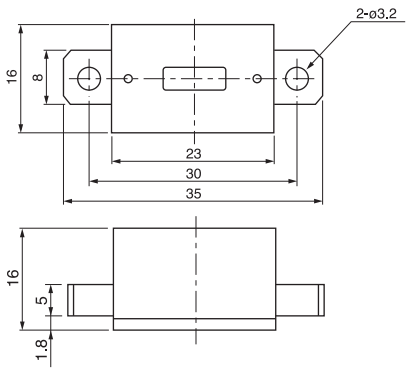
OUTPUT SIGNAL



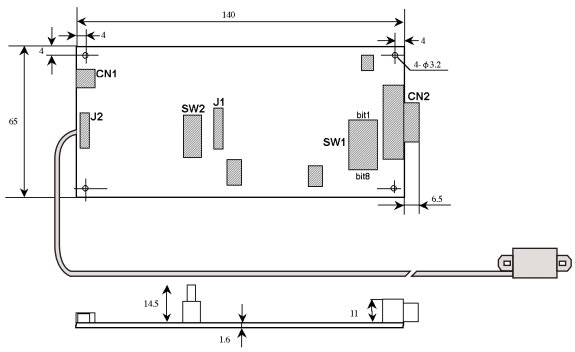
Pin No.	Item	Description
1	PCA- / UP-	Either A- phase square wave signal or UP-
2	PCA+ / UP+	Either A+ phase square wave signal or UP+
3	PCB- / DOWN-	Either B- phase square wave signal or DOWN-
4	PCB+ / DOWN+	Either B+ phase square wave signal or DOWN+
5	PCZ-	Z- phase square wave signal
6	PCZ+	Z+ phase square wave signal
7	ERR+	Encoder error signal
8	ERR-	Encoder error signal phase difference
9	RES+	Reset signal input terminal
10	D-GND	Digital ground
11	LD-ARM	Laser diode alarm
12~15	NC	No connection

EXTERNAL DIMENSIONS

●Head

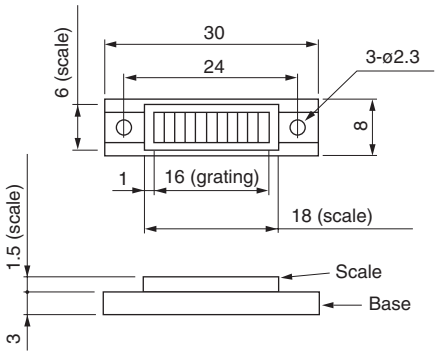


●Interpolator

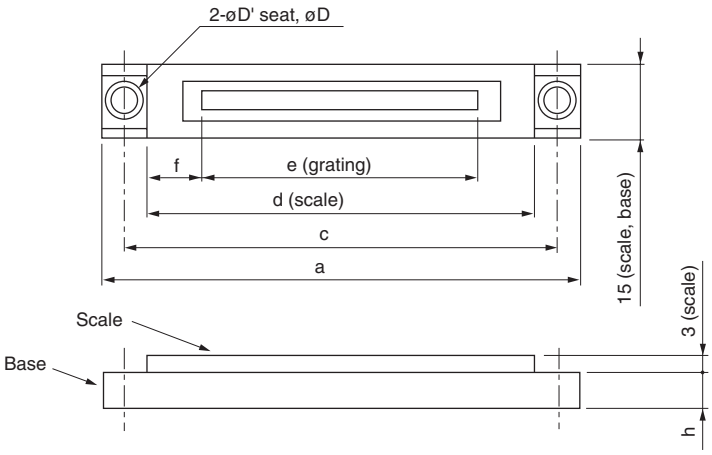


Scale

10mm scale



50,100,150mm scale



	a	c	d	e	f	h	D'	D	Effective range
50mm scale	100	90	80	60	10	7	-	3.6	56
100mm scale	160	145	130	110	10	8	9.5	4.4	106

Note) Z phase signal is got at 3.2±0.5mm inside from both end of grating.

Installing and Adjustment

1. Surface accuracy for scale installation

- ●Flatness : 10μm and less
- ●Roughness : 5μm and less

2. Permissible level for installation

Signal amplitude is reduced when the position relation between scale and head is beside optimal position as the following figure.

The deviation that makes 30% reduce of signal amplitude is shown in following table.

The value in the column ε is the range of no reduction.

	ML-08	ML-16
α	±2arc-min	±4arc-min
β	±2arc-min	±3arc-min
γ	±5arc-min	±10arc-min
δ (scale length : 10mm)	(2.5~3.1) ±0.2mm	(6.5~8.9) ±0.3mm
δ (scale length : 50, 100, 150mm)	(1.5~2.1) ±0.2mm	(5.5~7.9) ±0.3mm
ε	±1.0mm	±1.0mm

Declination from ideal position