Celera MOTION | MicroE *Encoders*

PRODUCT DATA SHEET

NANO

Optira™ Series Encoders

Miniature Precision Encoders for the World's Smallest Spaces

By combining the patented PurePrecision™ technology of MicroE encoders with state-of-the-art electronics and signal processing, the Optira Series delivers unprecedented performance in an incredibly small and lightweight package.

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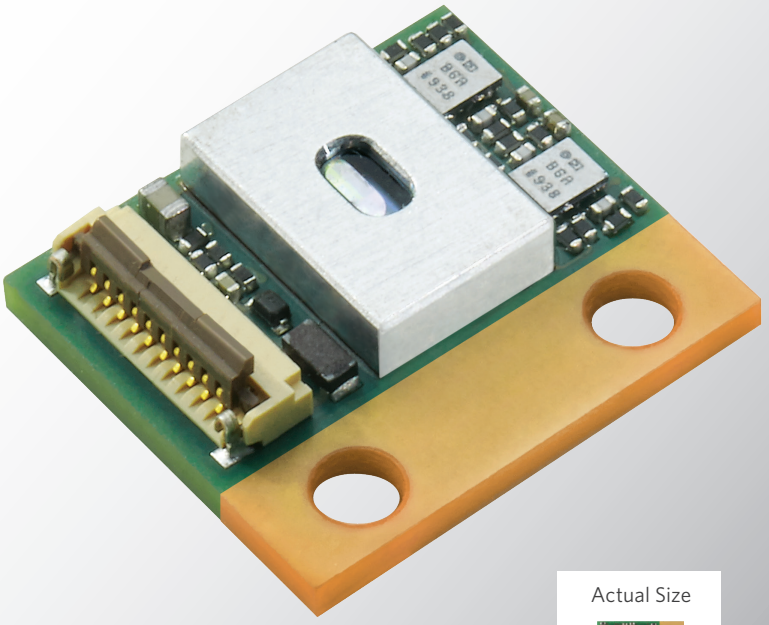
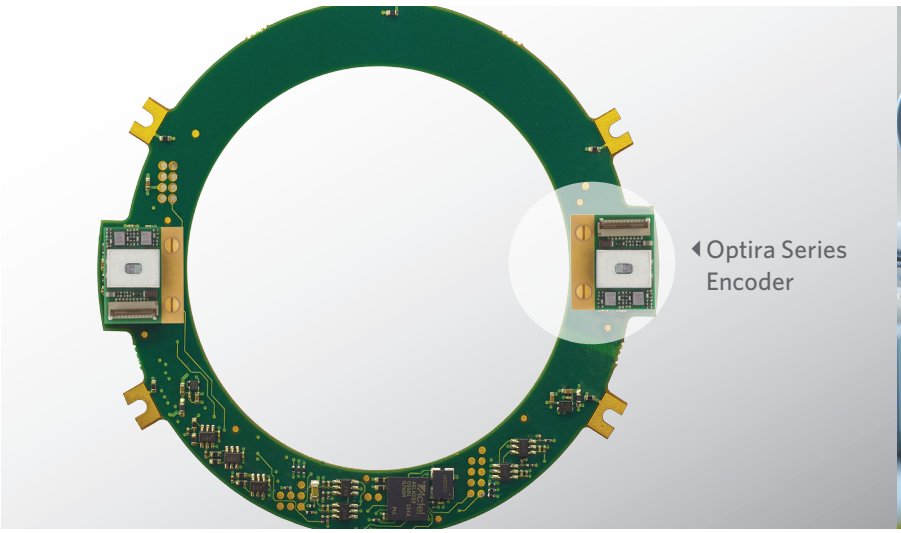


MEDICAL | INDUSTRIAL | SCIENTIFIC | MICROELECTRONICS

Accelerate Your Innovation.

Optira™ Series Encoders

Miniature Precision Encoders for the World's Smallest Spaces



Smaller and Smarter.

Optira is the only encoder in its size class that offers up to 5 nm resolution with all interpolation, AGC, and signal processing performed in the sensor head. No additional PCBs, adapters, or dongles are required for operation.

Patented PurePrecision™ optical technology and industry-leading alignment tolerances from our MicroE encoders make Optira's miniature sensor head extremely easy to install. Optira's two mounting options, industry standard analog and digital incremental encoder outputs, and standard FFC connector provide the durability and flexibility needed by designers of miniature precision motion control systems.

Optira is engineered to deliver industry-leading low power consumption. A 3.3 VDC version is offered, making it ideal for battery-powered precision instruments.

Compatibility with our wide range of linear and rotary gratings and scales enables a miniature installation footprint.

Benefits

- Miniature footprint; interpolation and signal processing in sensor head
- Mechanical and PCB-mount options
- Easy installation
- Simple and flexible cabling/connectivity
- Durable mechanical and electrical design
- Multiple linear and rotary grating/scale options
- Alignment/Status LED in sensor head
- Optional connector board for index calibration and connector flexibility

Specifications	
Dimensions:	11.4 x 13.0 x 3.7 mm
Interfaces:	A-quad-B digital or 1 Vpp Sin/Cos analog
Resolution: (Interpolation in Sensor Head)	5 µm – 5 nm (linear) 2,000 CPR – 75M CPR (rotary)
Accuracy Class:	+/- 1 µm (linear glass) +/- 5 µm (linear metal tape) +/- 2 arc-seconds (rotary)
Input Voltage:	3.3 VDC or 5 VDC
Supply Current:	130 mA with 120Ω across A, B, I 100 mA with 120Ω across Sin/Cos, IW
Max Speed:	4 m/s
Index:	IW for analog and 5 µm digital LSB for 2.5 µm digital and above
Outputs:	Sin/Cos or A-quad-B, Index, Alarm
Status LED:	Yes
Operating Environment:	Atmospheric (standard) Vacuum version available
Scale Pitch:	20 µm
Repeatability: (Hysteresis)	≤ 1 LSB
Typical Sub-Divisional Error (SDE):	< 100 nm RMS
Weight:	< 1.5 g
Grating Compatibility:	Linear and Rotary

Specifications subject to change.

RoHS
CE

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Specifications

System

Scales
Optira Series Encoders are compatible with Optira Tape, Linear Glass, and Rotary Glass Scales

Scale Pitch	20 µm
System Resolution	5 µm, 2.5 µm, 1µm, 0.5 µm, 0.2 µm, 0.1 µm, 50 nm, 20 nm, 10nm, 5nm. Analog 1 Vpp 2,000 CPR - 75M CPR (rotary) (Specify resolution at time of ordering)

Accuracy

Tape	SDE:	<100 nm RMS
	Linearity:	≤±5 µm (max/meter)
	Slope:	≤±150 µm/m
Linear Glass	SDE:	<100 nm RMS
	Total Accuracy:	<±1 µm/m[1]
Rotary Glass	Total Accuracy:	±2 arc-seconds[2]

Sensor Size and Weight	Length	Width	Height
Dimensions (mm):	13.0	11.4	3.7
Weight:	<1.5 g sensor head		

Sensor Cable	ZIF Flat Flexible Cable (FFC) 10 pins, lengths up to 5 m

Reliability Information
MTBF > 200,000 hours under normal operating conditions (calculated using MIL-STD-217)

Notes:
1. 130 mm or less
2. 125 mm diameter, excludes eccentricity

Operating and Electrical Specifications

Agency Standards Compliance: In accordance with Electromagnetic Compatibility Directive 2004/108/EC: CE

EN 55011, Class B:	Radiated Emissions
EN 61000-4-3:	Radiated Immunity
EN 60068-2-6:	Vibration
EN 60068-2-27:	Mechanical Shock

Power Supply Current

AquadB, 3.3 and 5 VDC ±5%:	<130 mA with 120Ω across A, B, I <75 mA with no load
Analog, 3.3 and 5 VDC ±5%:	<100 mA with 120Ω across Sin/Cos,IW <75 mA with no load
Ready Time:	<0.5 s once power >4.5 V

Temperature

Operating:	0°C to 70°C
Storage:	-20°C to 85°C

Humidity

Operating:	Up to 85% RH, non-condensing
Storage:	Up to 85% RH, non-condensing

Vibration	10 g, 55 Hz to 2 KHz
Mechanical Shock	500 m/s², 6 ms, ½ sine

Outputs
Digital AquadB: A, B, and Index outputs are differential
Alarm is single-ended open collector
Analog outputs are differential sine and cosine

Signal levels
A/B/I (differential): RS-422 compatible
A/B/I (single-ended): Voh min: Vcc - 0.4 VDC, Vol max: 0.4 VDC,
Alarm: Voh min: Vcc, Vol max: 0.4 VDC
Analog: 1 Vpp, 2.5 V offset @ 5 VDC, 1.65 V @ 3.3 VDC

Maximum Velocity (Digital)

Maximum Velocity (before Overspeed Buffer Protection[3]) vs. Interpolation Depth

Controller Recommended AqB Maximum State Rate (MegaStates/Sec)	Actual Encoder AqB Maximum State Rate (MegaStates/Sec)	5000	2500	1000	500	200	100	50	20	10	5	Resolution (nm)
		4	8	20	40	100	200	400	1000	2000	4000	Interpolation Depth
20	14.50	4000	4000	4000	4000	2900	1450	725	290	145	72	Maximum Velocity (mm/s)
10	7.25	4000	4000	4000	3625	1450	725	362	145	72	36	
5	3.63	4000	4000	3625	1812	725	362	181	72	36	18	
2	1.45	4000	3625	1450	725	290	145	72	29	14	7	
1	0.73	3625	1812	725	362	145	72	36	14	7	3	

Note[3]:
1. Optira implements Overspeed Buffer Protection (OBP). No AqB counts are lost for velocities below 4830 mm/s even if the maximum specified state rate is exceeded. If the velocity exceeds the specified state rate, the AqB counts are buffered (buffer length = 21 m at 4000x interpolation depth) and transmitted at the specified state rate.
2. The ALARM bit sets TRUE at 4 m/s, however, Optira will continue to produce valid AqB outputs up to 6 m/s although accuracy specifications are no longer guaranteed.

Maximum Velocity (Analog)

Sine/Cosine Vector Magnitude: >0.5 Vpp at 4 m/s

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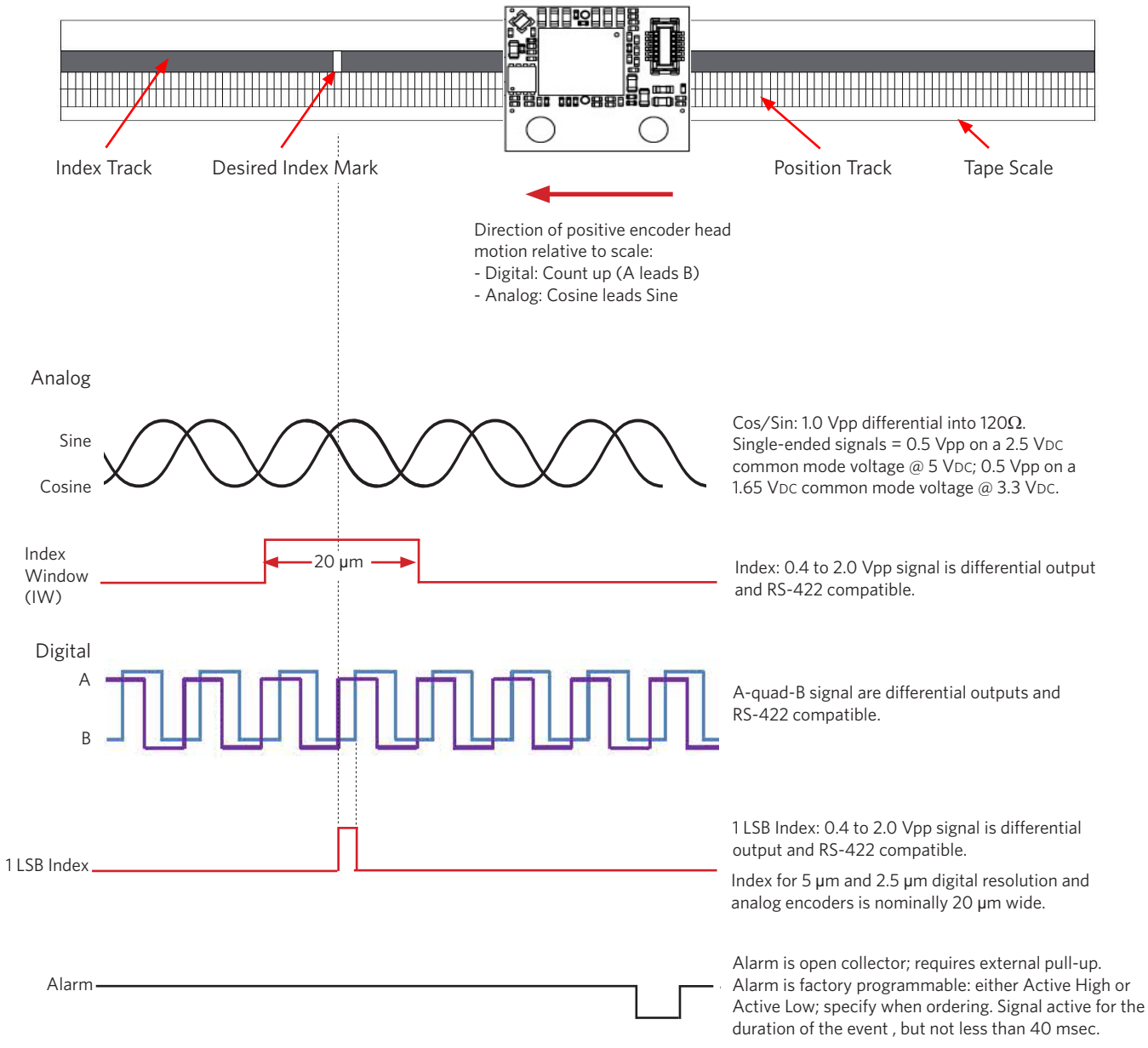
Output Signals



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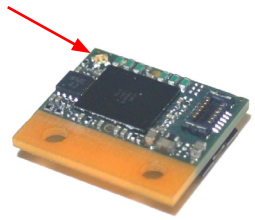
Optira Sensor

System Status LED

Optira Series Encoders have a built-in Status LED that displays alignment quality, index/limits detection, and alarms.

Status LED



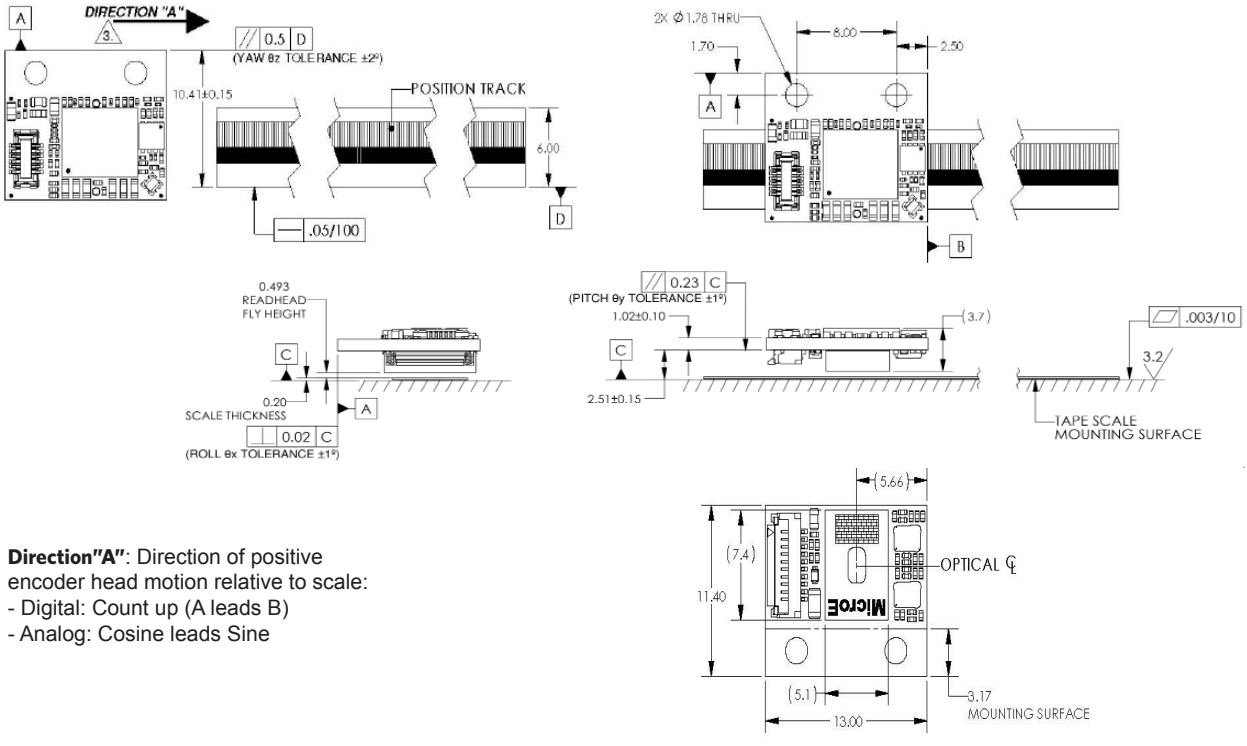
LED Color[1]	System Status
Green	Optimal alignment: • Optimal position signal with minimum power consumption • Encoder system meets specification
Greenish Yellow	Good alignment: • Optimal position signal at specified power consumption • Encoder system meets specification
Orange	Alignment could be improved but fully operational: • Sensor is reading position with marginal signal strength • Encoder system functions but vector magnitude may not be 1 Vpp and SDE may exceed specification
Red	Sensor fault: • Sensor is reading position with weak signal strength, or • Power supply is less than 4.2 V (5 VDC), 2.8 V (3.3 VDC), or • Power supply is greater than 5.5 V (5 VDC), 3.8 V (3.3 VDC), or • Sensor moving faster than 5.8 m/s. • Encoder system may not function properly • Alarm signal will be asserted

LED indications for Index Detection

- LED flashes bright when passing over index
- LED stays right if stopped over index

Note[1]: The Status LED can be ordered with all four colors available, or only with red available for an alarm indication (see in How to Order).

Interface Drawing



Direction"A": Direction of positive encoder head motion relative to scale:
- Digital: Count up (A leads B)
- Analog: Cosine leads Sine

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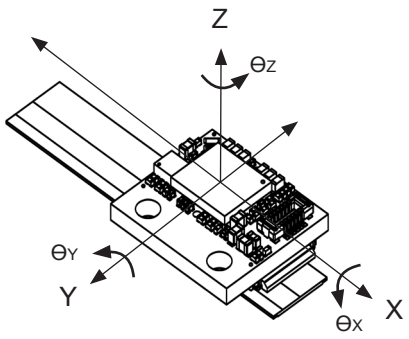
Wide Alignment Tolerances

The Optira Series Encoder utilizes MicroE's patented optical detector design to achieve industry-leading small sensor size and alignment tolerances. The compact sensor is easily installed without any alignment tools or oscilloscopes. To align and calibrate the sensor is a simple step-by-step process.

Optira Series Encoders Sensor Alignment Tolerances	
Axis	**Alignment Tolerance**
X	Direction of Motion
Y	±0.15 mm
Z	±0.1 5 mm
Θx	±1.0°
Θy	±1.0°
Θz	±2.0°

Alignment Axes



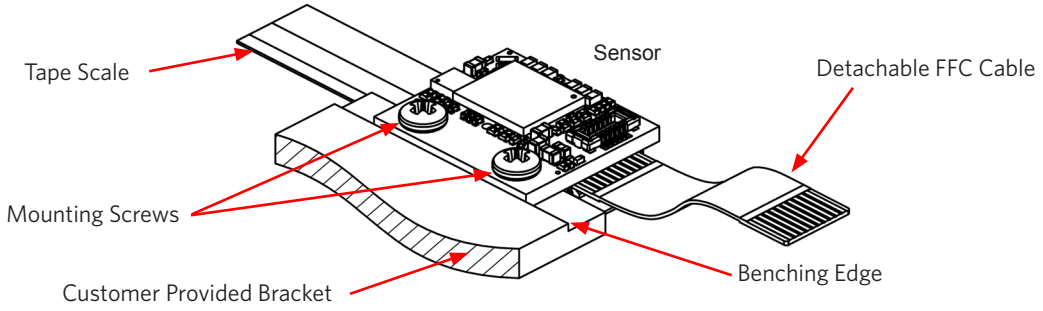
Sensor Mounting Options

There are two option for mounting the Veratus sensor:

1. Mechanical mounting
2. Board-to-board connection to customer's PCB

Mechanical Mounting

The Optira sensor can be mounted directly to the customer's bracket or equivalent surface using two mounting screws.



Recommended Customer Required Parts

The following parts or their equivalents are recommended for the mechanical mounting of the Optira sensor:

Item	Mounting Scheme
Mounting Screws (2)	M1.6 or 0-80 screws: Philips-head screws are recommended. **Do not use** slotted-head screws which can cause the screwdriver to slip and damage components. Torque specification: 0.34 Nm (3.0 inch-lbs) maximum. **Caution**: Be careful tightening these screws to avoid damaging nearby components.
FFC Cable	Flexible Flat Cable (FFC): 0.5mm, Type 1, 10P. Maximum length of 5 m. J1 ZIF connector is Hirose® FH33J-10S-0.5SH(10). If long flex cables are needed, contact Selmark Associates for Parlex® cables or contact another equivalent manufacturer. For high mechanical stress environments, secure FFC to ZIF connectors using non-conductive epoxy.
ZIF Connector	Various FFC connectors: surface mount, ZIF, 10P, 0.5 mm pitch.
Z-Height Shim Spacer	• Shim for installing sensor • Part of optional Development Kit 
Applicator Tool	For tape scale installation 

Board-to-Board Mounting

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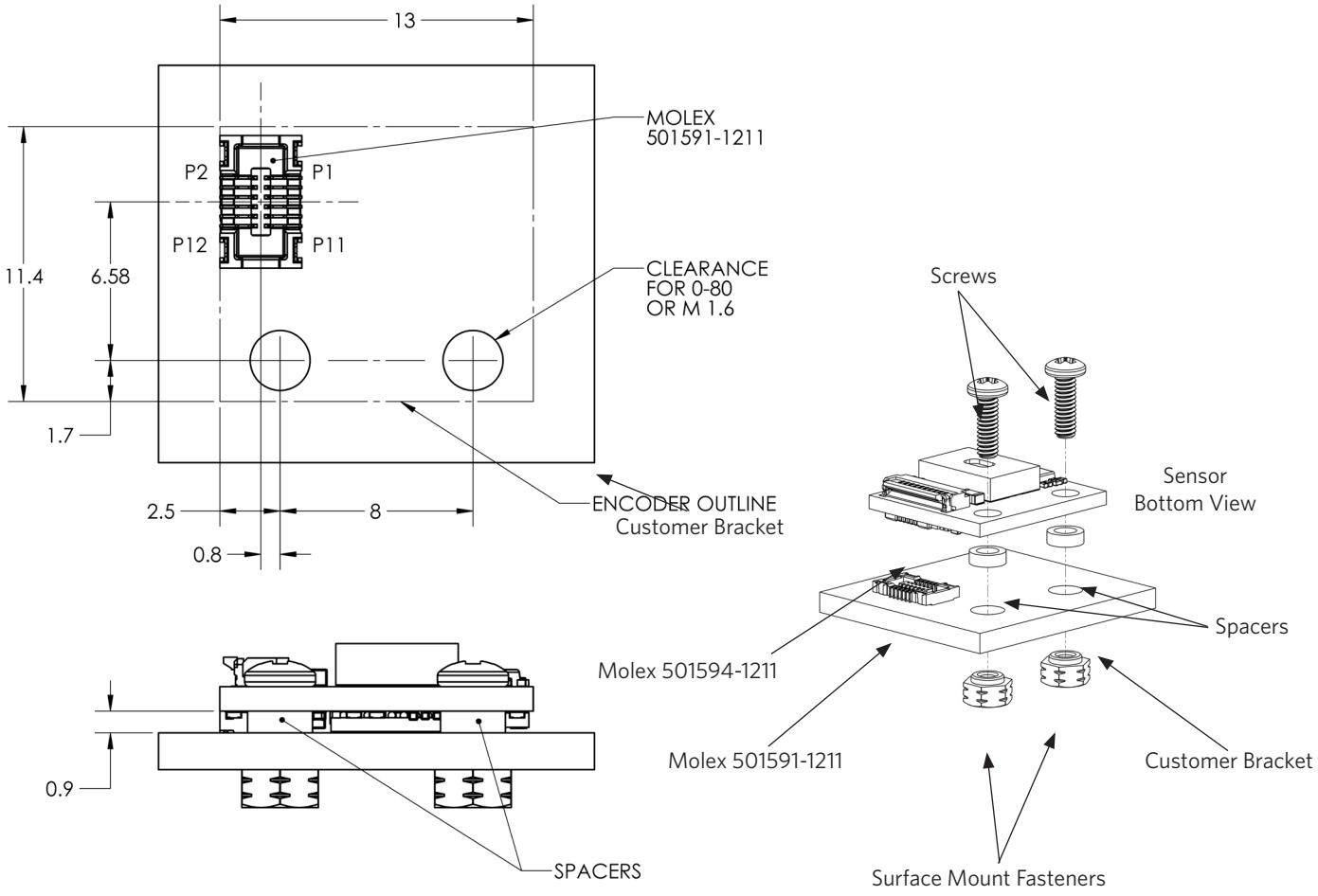
The Optira sensor can be connected directly to the customer's PCB using the sensor board-to-board header mating connector JP1.

Reference Design for Mating Sensor to PCB



Recommended Customer Required Parts

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PC Mount Connector[1]	Molex® part number 501591-1211: 0.40 mm (.016") pitch; board-to-board vertical mating receptacle; mates to JP1 board-to-board connector (Molex part number 501594-1211) on sensor.
Spacers (2)	Diameter of spacers cannot exceed keep-out area of 3.17 mm (see Sensor Dimensions on page 5); height is 0.9 mm.
Surface Mount Fasteners (2)	MicroPEM® Fasteners: Type SMTSO .060-80 (#0-80) or equivalent

Note[1]: Header Mating: the header mating connector has a limited durability of 20 mating cycles maximum.

Header Examples

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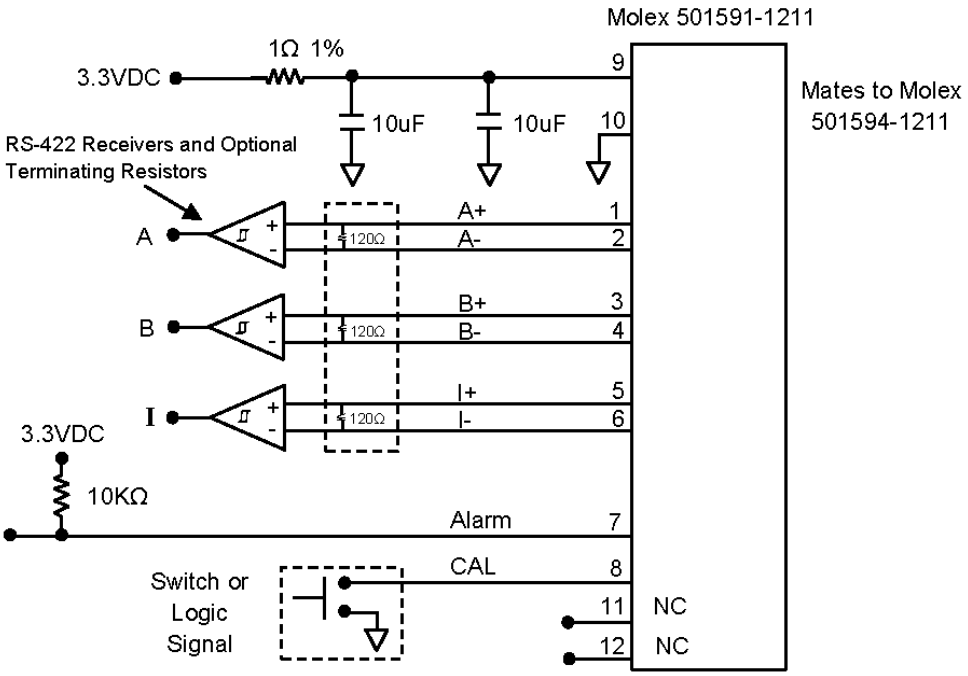
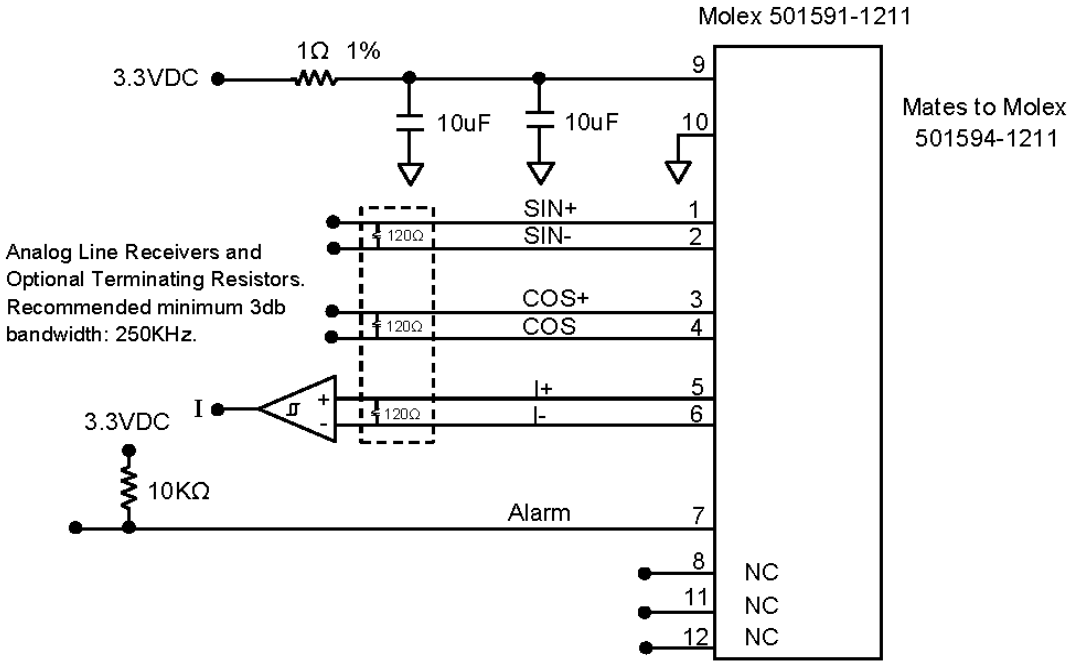
The following are sample customer circuits for connecting the Optira sensor using board-to-board mounting.

3.3 VDC Digital Operation



3.3 VDC Analog Operation



5 VDC Digital Operation

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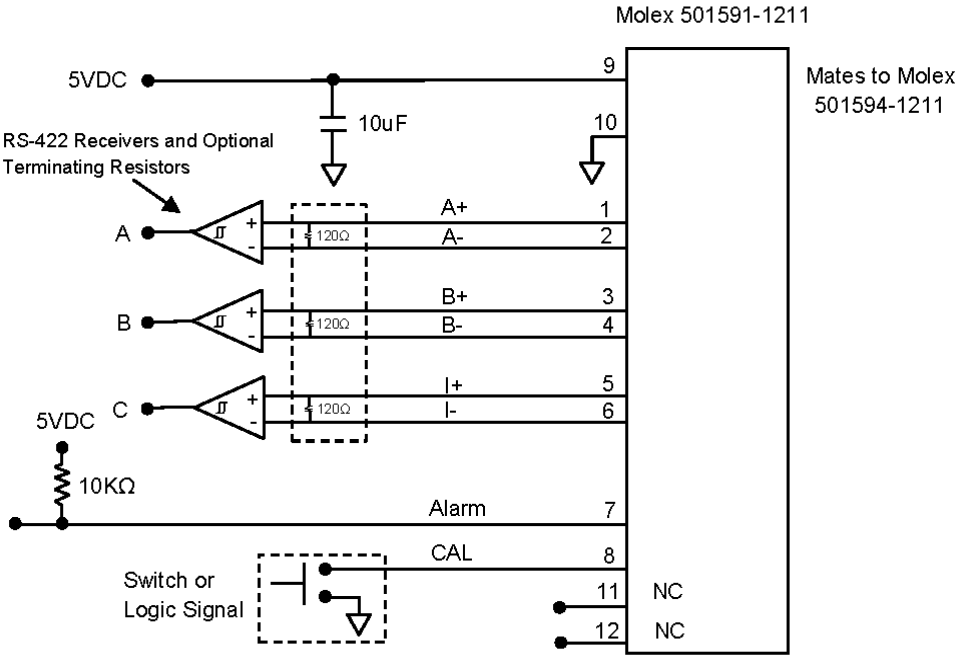
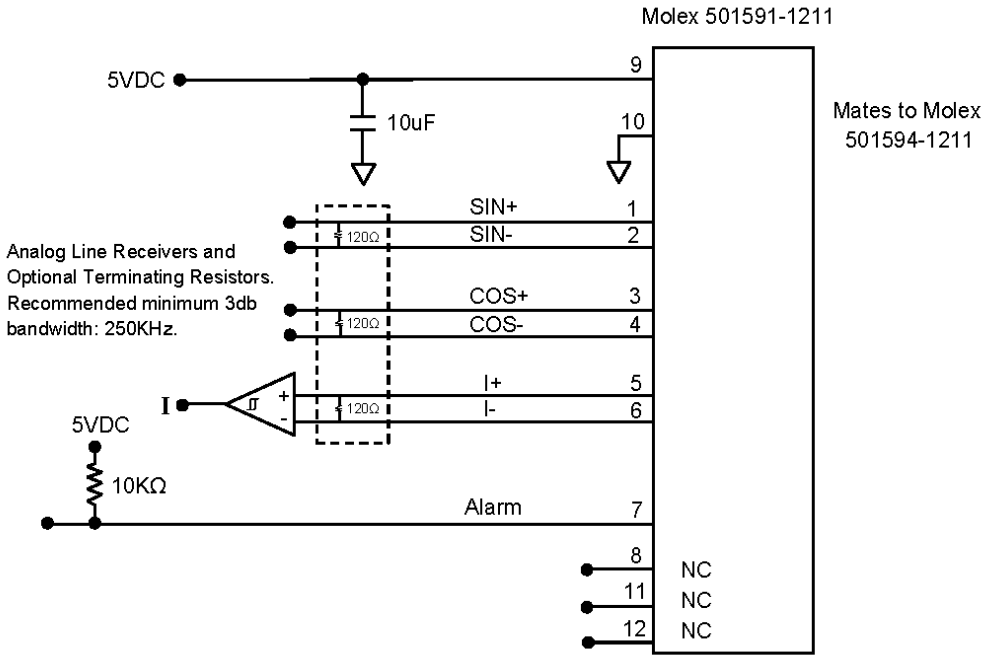


5 VDC Analog Operation



Sensor Connectors

The following are the pinouts for the two connectors on the Optira sensor.

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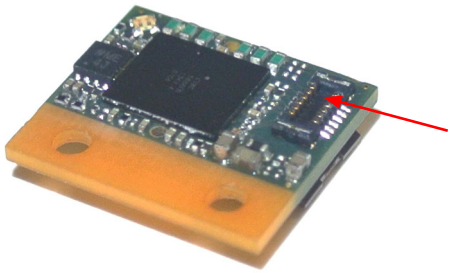
JP1 - Low Profile Board-to-Board Header Connector

Manufacturer Part Number: Molex® 501594-1211

Pin Number	Signal	
	A-quad-B	Analog
1	A+	SIN+
2	A-	SIN-
3	B+	COS+
4	B-	COS-
5	Index+	Index+
6	Index-	Index-
7	Alarm	Alarm
8	CAL	CAL
9	PWR	PWR
10	GND	GND
11	NC	NC
12	NC	NC

NC - No Connect

Optira Sensor Top View



JP1 - Board-to-Board Header Mating Connector[1]

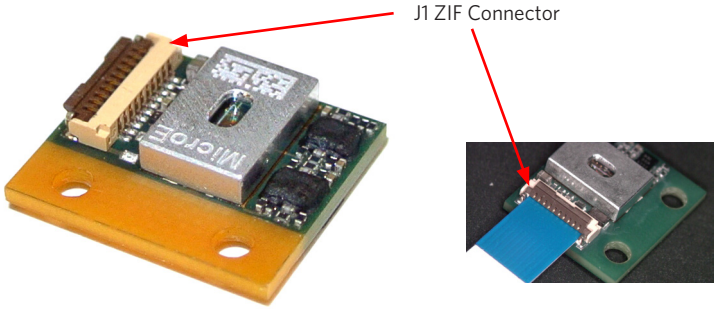
Note[1]: The 12-pin header mating connector has a limited durability of 20 mating cycles maximum.

J1 - ZIF Connector

Manufacturer Part Number Hirose® FH33J-10S-0.5SH(10)

Pin Number	Signal	
	A-quad-B	Analog
1	A+	SIN+
2	A-	SIN-
3	B+	COS+
4	B-	COS-
5	Index+	Index+
6	Index-	Index-
7	Alarm	Alarm
8	CAL	CAL
9	PWR	PWR
10	GND	GND

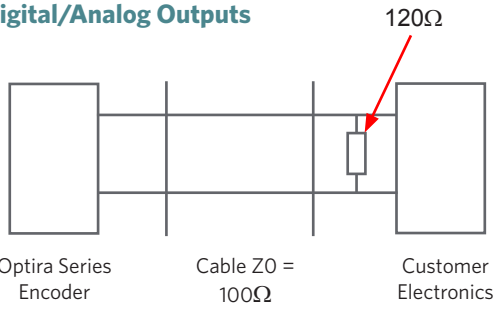
Optira Sensor Bottom View



Recommended Signal Termination

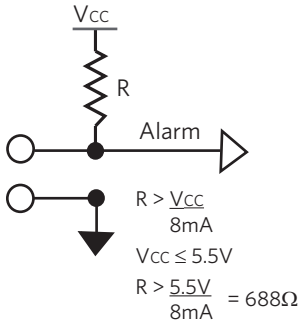
Note: Below values are applicable to 5 V models only.

Digital/Analog Outputs



Alarm

Alarm output is an open collector circuit that is factory programmable: either active high or active low; specify when ordering. Alarm requires an external pull-up resistor. See customer-supplied circuit example to right.



Note: Maximum cable length is 5 m. Contact MicroE Applications Engineering if longer lengths are required.

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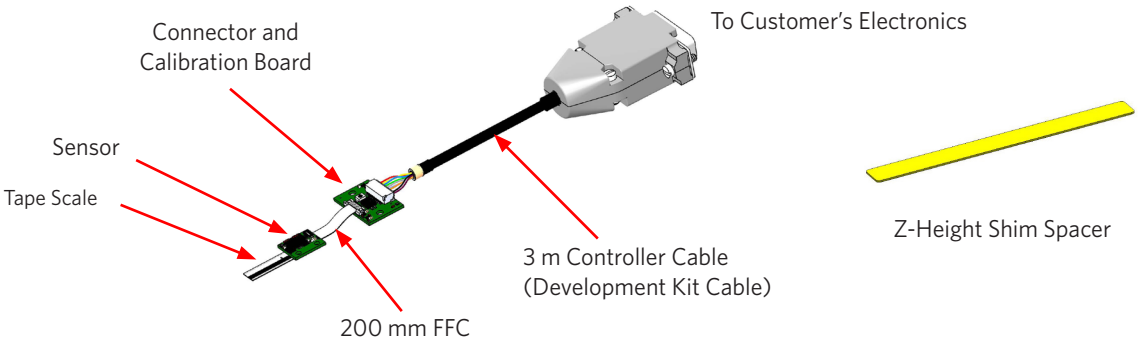
Optional Development Kit

Model: PI-DK

The following are the components of the optional Development Kit:

Part	Description
Connector and Calibration Board	Interface board located between the Optira sensor and the customer's controller: • Provides feedback of sensor operation to customer's electronics • Provides control for calibration and alignment • Size: 0.591" x 0.886" • No signal processing
200 mm FFC Cable	Flexible Flat Cable (FFC) that connects sensor to optional interface board or directly to customer's electronics: • Digikey 732-3556-ND • Wurth Electronics® part number 687610200002 (0.5 mm, Type 1, 10P, 200 mm)
3 m Controller Cable	Custom Development Kit Cable with JST® connector and 15 Pin D-Sub to connect between the Connector and Calibration Board and customer's electronics
Z-Height Shim Spacer	Shim for installing sensor. Sets gap between sensor riser and top of installed scale.



Connector and Calibration Board

Provides an interface board between the Optira sensor and customer's electronics. Does not contain any signal processing. Can be ordered separately from the development kit.

Main Components

Two Connectors for connecting to sensor and customer's electronics:

- J1 ZIF Connector
- J2 Shrouded Connector

Calibration Button:

- Located on top of the PCB
- Press to initiate calibration procedure

Note: Calibration button is only needed when the LSB option is selected for the index (see How to Order).

Two LEDs:

- Red for Alarm
- Green for Power On

DIP switch (two settings) for configuring LEDs:

- Configurable alarm - active high or low
- Configurable Power On LED - either on or off
- Factory defaults - alarm is active low; green Power On LED is on

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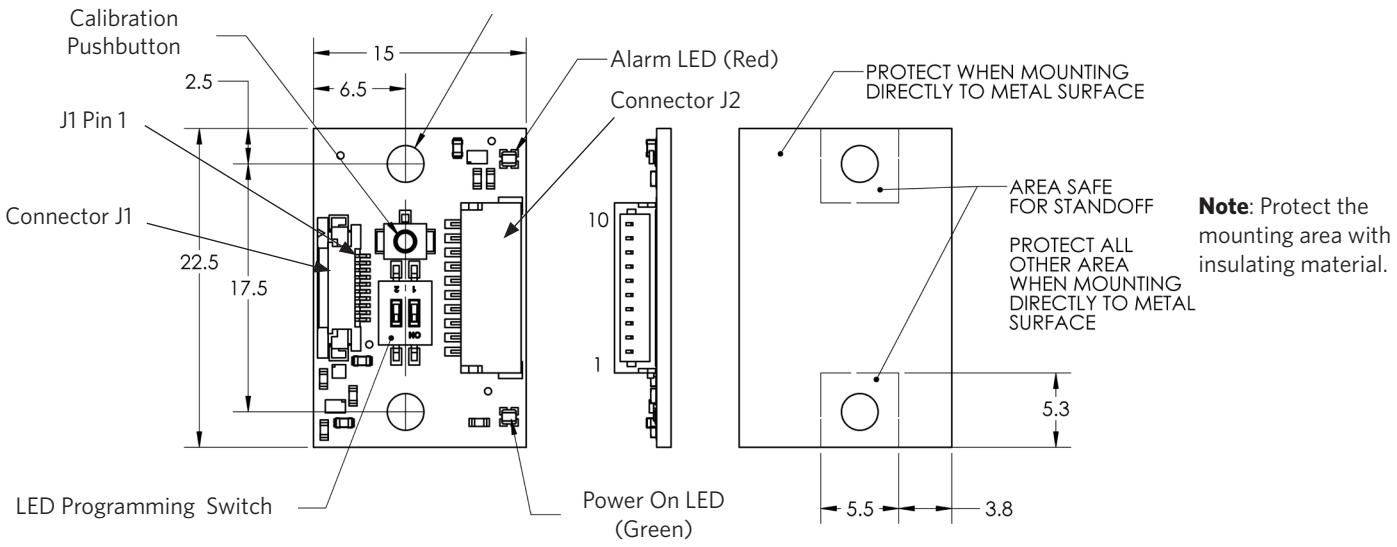
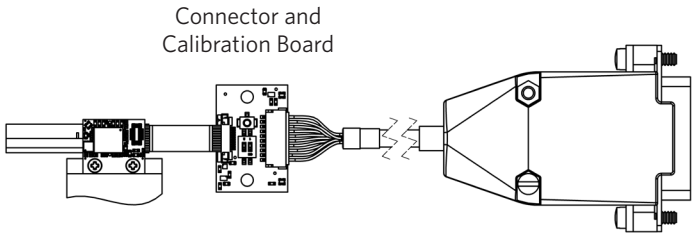
Dimensions and Connectors for the Connector and Calibration Board



Note: Protect the mounting area with insulating material.

Recommended Mounting and Cabling

Connector and Calibration Board connected to sensor and development kit cable:



Recommended Customer Required Parts

The following parts or their equivalents are recommended for using the Connector and Calibration Board:

Item	Mounting Scheme
Heading Connector	JST SM10B-SRSS-TB(LF)(SN): Shrouded head connector, SH 10 Position, side entry type, 1.0 mm pitch, crimp style.
Screwdriver	WiHa 26008: Small slotted plastic screwdriver [.8 (1/32) x 40 mm] to change settings on the DIP switch on the Connector and Calibration Board.
FFC Cable	Flexible Flat Cable (FFC): 0.5mm, Type 1, 10P, maximum length of 5 m; refer to manufacturer's specification. If long flex cables are needed, contact Selmark Associates for Parlex® cables or contact another equivalent manufacturer.
Crimping Tool	JST 455-2569-ND: Crimping tool for JST P/N 455-1561-2-ND, Connector Terminal SH Crimp 28 - 32 AWG Tin.

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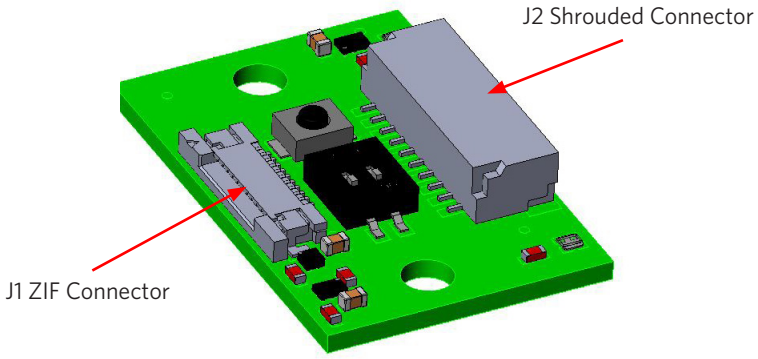
Connector and Calibration Board Connector Pinouts

Connector J1 - Flat Flexible Cable (FFC) connecting sensor to optional board ZIF connector J1

Manufacturer Part Number: Omron® XF2L-1025-1A

Pin Number	Signal	
	A-quad-B	Analog
1	A+	SIN+
2	A-	SIN-
3	B+	COS+
4	B-	COS-
5	Index+	Index+
6	Index-	Index-
7	Alarm	Alarm
8	CAL	CAL
9	PWR	PWR
10	GND	GND

Connector and Calibration Board



Connector J2 - JST 10-pin connector on optional board

Manufacturer Part Number: JST SM10B-SRSS-TB(LF)(SN)

Pin Number	Signal	
	A-quad-B	Analog
1	A+	SIN+
2	A-	SIN-
3	B+	COS+
4	B-	COS-
5	Index+	Index+
6	Index-	Index-
7	Alarm	Alarm
8	CAL	CAL
9	PWR	PWR
10	GND	GND

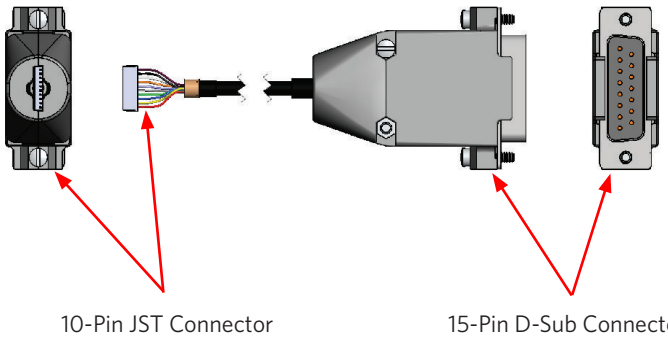
Development Kit Cable

15-Pin D-Sub/10-Pin JST Cable from optional board to customer's interface

10-Pin JST	Signal		15-Pin D-Sub
	A-quad-B	Analog	
NC	NC	NC	1
NC	NC	NC	2
Pin 6	Alarm-	Alarm-	3
Pin 5	Index-	Index-	4
Pin 1	B-	COS-	5
Pin 7	A-	SIN-	6
NC	NC	NC	7
Pin 10	PWR	PWR	8
Pin 2	GND	GND	9
NC	NC	NC	10
Pin 3	Alarm+	Alarm+	11
Pin 8	Index+	Index+	12
Pin 4	B+	COS+	13
Pin 9	A+	SIN+	14
N/A	Inner Shield	Inner Shield	15

NC - No Connect, N/A - Not Applicable

Development Kit Cable



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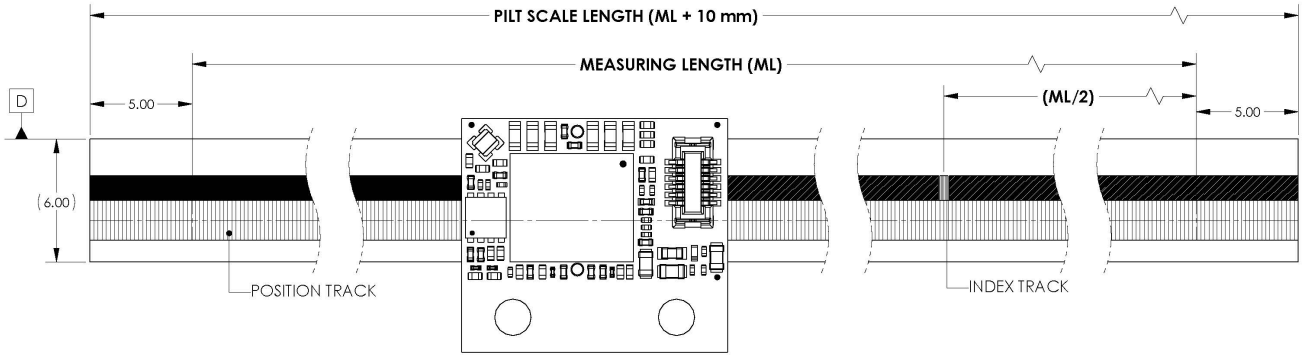
Optira Tape Scales

Model: PILT

Optira Linear Tape Scales are adhesive-backed metal tape scales, which are only 6 mm wide and easily installed on virtually any surface using standard adhesive backing while achieving industry-leading price and performance. Optira tape scales provide linearity of ≤±5 µm (max/meter) and are easily cut to length in the field and can be ordered in customer-specified lengths up to 20 m.



Specifications

Linearity	≤±5 µm (max/meter)
Material	Inconel 625
Typical CTE	13 ppm/°C; thermal behavior of the tape scale is typically matched to the substrate using epoxy at the ends of the tape scale

Tape Scale Applicator Tool for Optira Series Encoders

- Use the Tape Scale Applicator Tool Model PILT-AT for scale lengths greater than 0.3 meters.
- The Applicator Tool enables fast and accurate installation of long scale lengths, which ensures optimal encoder performance.

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How to Order

Sensor

PIA-1000-A1-20-A (example)

- Status LED
  A=Green, Greenish-Yellow, Orange, and Red
  B=Red only (Alarm)
- AquadB Output Rate
  20=20 MegaStates/Sec
  10=10 MegaStates/Sec
  05=5 MegaStates/Sec
  02=2 MegaStates/Sec
  01=1 MegaStates/Sec
  00=Analog 1 Vpp
- Index
  1=LSB[1] (2.5 µm and higher)
  0=Window (analog and 5 µm recommended)
- Alarm
  A=Open Collector, Active High
  B=Open Collector, Active Low
- Resolution
  5000=5 µm
  2500=2.5 µm
  1000=1 µm
  0500=0.5 µm
  0200=0.2 µm
  0100=0.1 µm
  0050=50 nm
  0020=20 nm
  0010=10 nm
  0005=5 nm
  0000=Analog 1 Vpp
- Sensor Type
  A=Standard 5 V Input
  B=Standard 3.3 V Input
- Model
  PI = Optira Incremental

Scales[2] - Optira Tape Scale

PILT-1000I-B-A (example)

- Mounting
  A=Adhesive
- Index Mark
  B=Center of measuring length
  C=Customer specified
  E=None
- Continuous or Individual
  C=Continuous lengths with cut marks
  I=Individual length (default selection for Index Mark types E)
- Scale Length[3]
  XXXXX=Length in mm
- Model
  PILT=Optira Tape Scale, Standard

Accessories

PI-DK	Development Kit: Connector and Calibration Board, 200 mm FFC Cable, 3 m Controller Cable, and Z-Height Shim Spacer for sensor installation
PI-CB	Connector and Calibration Board
PILT-AT	Tape Scale Applicator Tool (used for lengths >0.3 m)

Notes:

1. The Connector and Calibration Board is required for calibration when specifying LSB for the index.
2. Scales Availability: linear glass and rotary glass scales are available; contact MicroE for more details:
   - Linear Glass Scales: Model PILG, lengths up to 130 mm
   - Rotary Glass Scales: Model PIRG, diameters up to 130 mm
3. Does not apply for custom scales: contact MicroE for custom part numbers.

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