

# RLC2IC

## Miniature Incremental Magnetic Encoder Module

RLC2IC is a PCB-level incremental encoder system consisting of a PCB sensor and a magnetic scale or ring. It is designed for embedded motion control applications as a position control loop element in applications with limited space.

The state-of-the-art position detection guarantees a highly repeatable position measurement under wide mounting tolerances and temperature ranges. Position information is output in incremental quadrature format with the option of a unique or periodic reference mark (each pole).

SMALL SIZE  
& SIMPLE  
INTEGRATION

UNIQUE  
REFERENCE  
MARK

HIGH  
OPERATING  
TEMPERATURE



### Features and benefits

- ▶ Miniature design
- ▶ Four different termination options
- ▶ Unique or periodic bidirectional reference mark
- ▶ Incremental quadrature output RS422
- ▶ Suitable for use with linear scales, radial and axial rings
- ▶ High system accuracy up to  $\pm 10 \mu\text{m}$
- ▶ Non-contact and wear-free measuring principle



MEDICAL



PRINTING TECHNOLOGY



IN SMALL SIZE



ROBOTIC JOINTS



SMT PICK AND PLACE

## General information

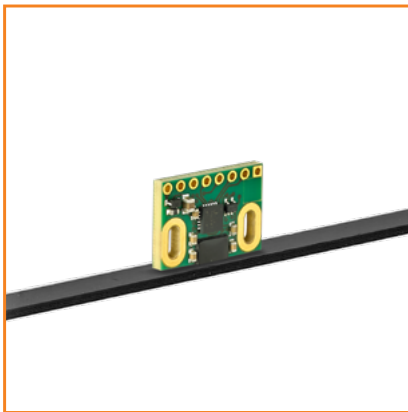
The RLC2IC is a small PCB-level encoder with differential incremental signals and the possibility of a reference signal. The encoder can be ordered with different types of connectors or through-hole pads and is very suitable for applications with limited space.

### Choose your RLC2IC system

The robust RLC2IC readhead is compatible with the RLS incremental scale MS05 as well as the RLS axial and radial rings. You can select the length of the MS05 scale up to 50 m. There is also a wide range of axial and radial incremental rings available.

To ensure safety and reliability, the scale MS05 and the radial rings can be optionally covered with a protective stainless steel foil. Unique or distance-coded reference marks are also available to provide an even more reliable solution.

#### RLC2IC + magnetic scale



More about the MS magnetic scales can be found in the MSD01 at [RLS media center](#).

#### RLC2IC + radial magnetic ring



More about the radial rings can be found in the MR02D02 at [RLS media center](#).

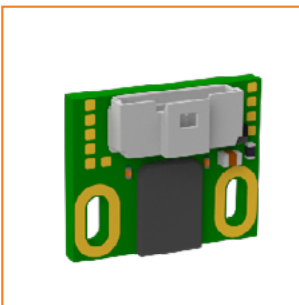
#### RLC2IC + axial magnetic ring



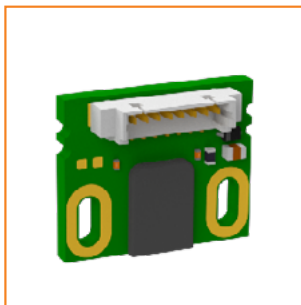
More about the axial rings can be found in the MR01D01 at [RLS media center](#).

### Encoder variants

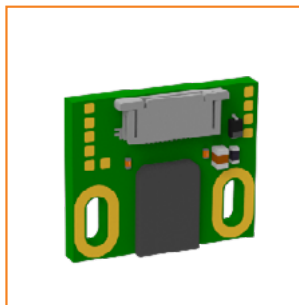
#### RLC2IC with Molex 5015681107



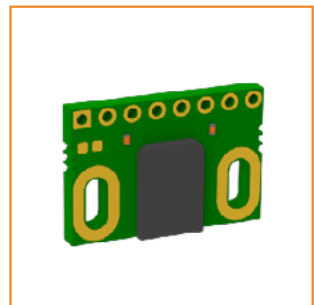
#### RLC2IC with AMPHENOL 10114828-11108LF



#### RLC2IC with Molex 527451197



#### RLC2IC with through-hole pads



Images are for illustration purpose only.

## Storage and handling

All data given below refer to the readhead only. Complete systems with magnetic scale or ring may have other limitations. For more information, see the MSD01, MR02D02 or MR01D01 data sheets at [RLS Media center](#).

### Storage and operating temperature

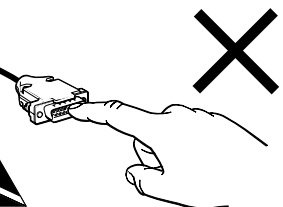
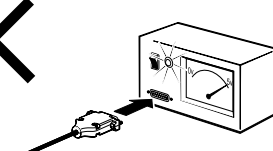
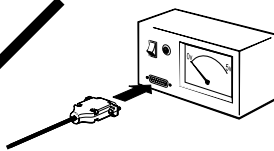


| Temperature       | Product variant with                          |
|-------------------|---|
| -40 °C to +85 °C  | Molex 527451197                               |
| -40 °C to +105 °C | Molex 5015681107<br>AMPHENOL 10114828-11108LF |
| -40 °C to +125 °C | Through-hole                                  |

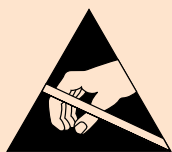
### Humidity



Up to 70 % non-condensing



The encoder is a mechanically sensitive component. Handle it by its edges, touch it lightly, minimize pressure and eliminate bending while maintaining a secure grip to prevent falls. Maximize cleanliness. When it's not in use, place it in an ESD protective packaging (box or tray).



### Readhead is ESD sensitive - handle with care.

Do not touch electronic circuit, wires or sensor area without proper ESD protection or outside of ESD controlled environment.

## Packaging

Less than 20 units are individually packed in antistatic boxes. For quantities of 20 pieces or more, the readheads are packed in trays (see table below). The trays are packed together in a cardboard box (20 trays per box).

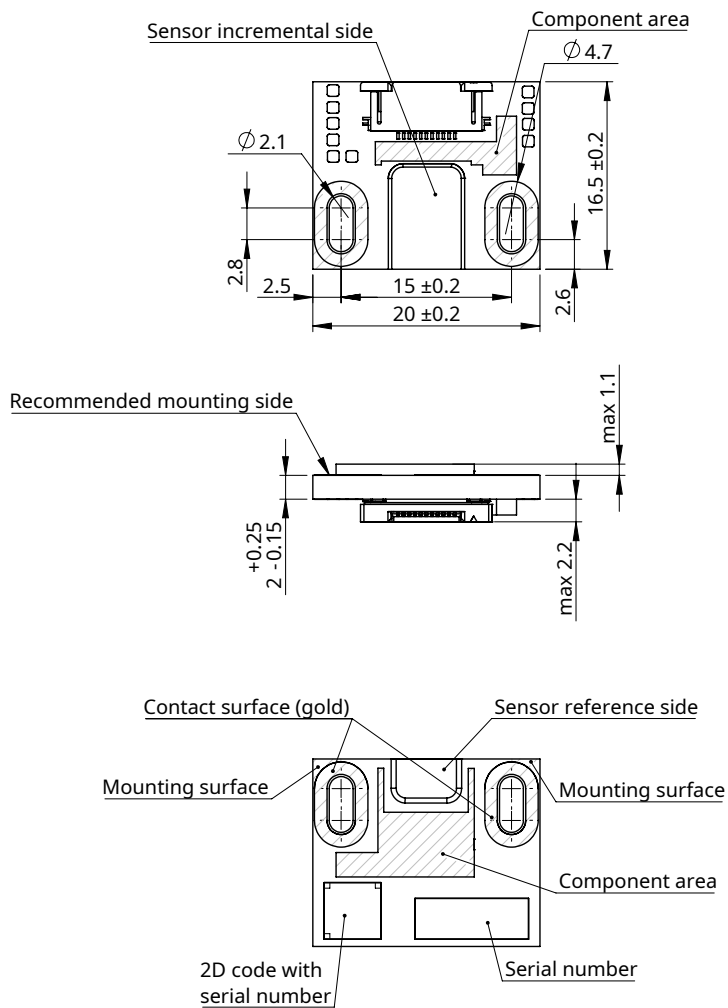
| Product variant               | Tray size         | Box size         |
|-------------------------------|-------------------|------------------|
| RLC2IC with through-hole pads | 28 units per tray | 20 trays per box |
| RLC2IC with connector         | 30 units per tray |                  |

## Dimensions and installation drawings

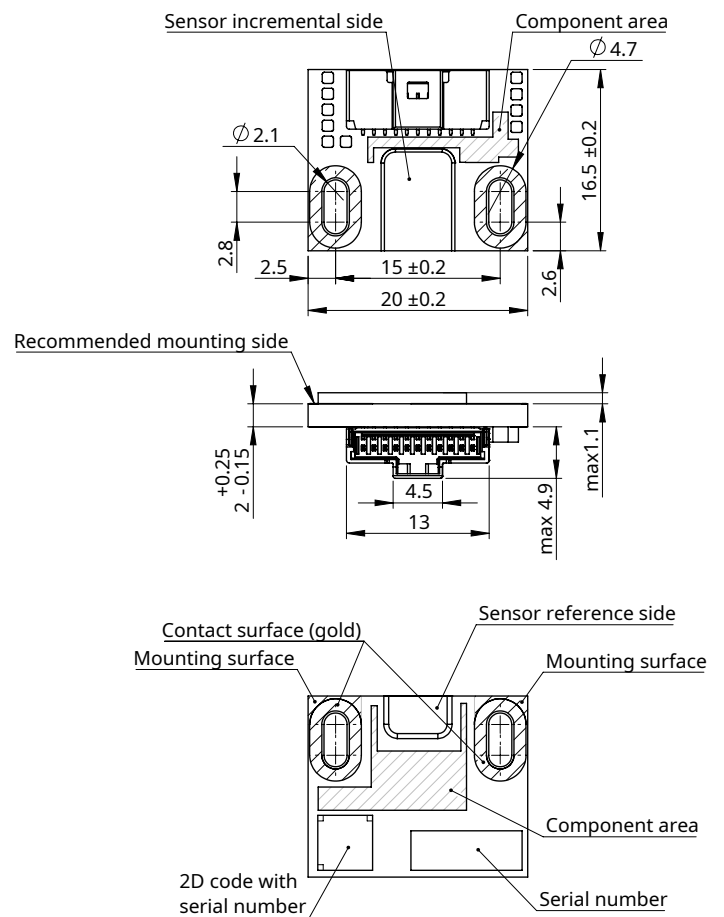
Dimensions and tolerances are in mm. Dimensions without tolerance values are in accordance with ISO 2768-m.



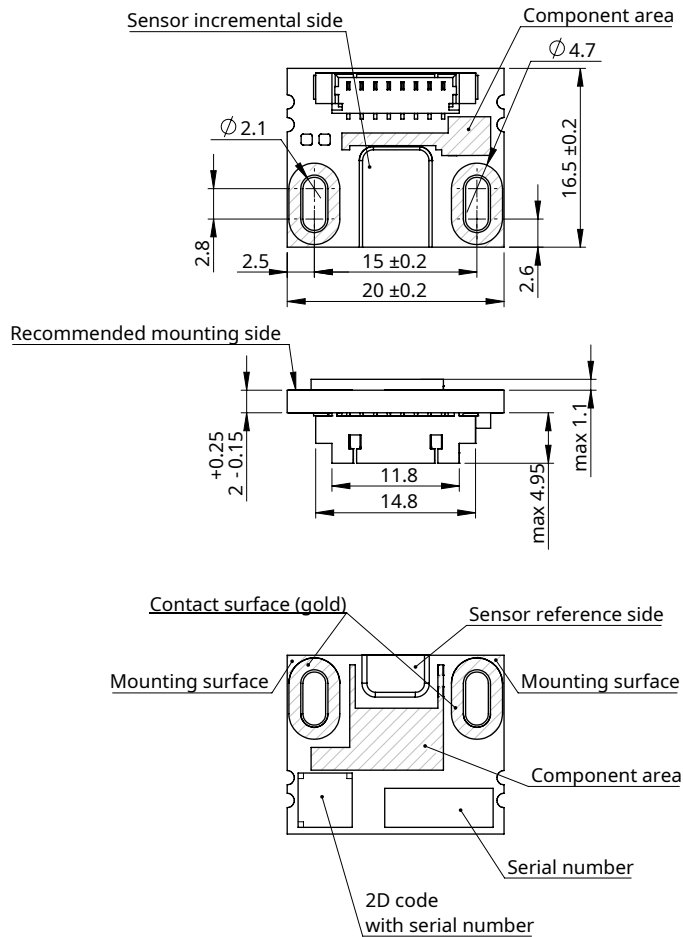
### RLC2IC with Molex 527451197



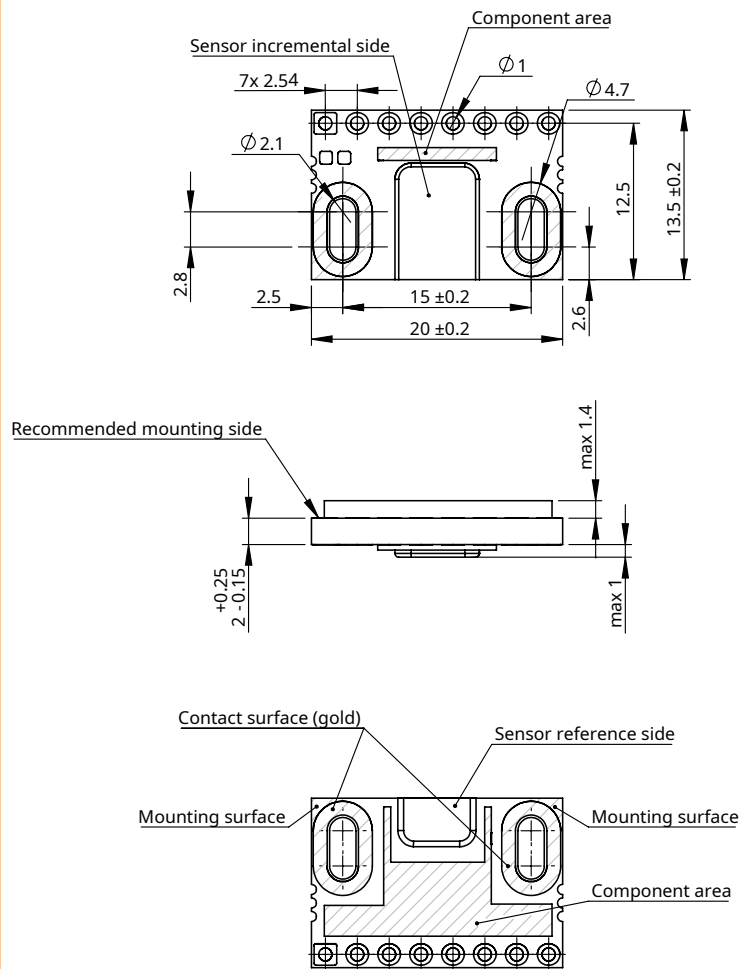
### RLC2IC with Molex 5015681107



## RLC2IC with AMPHENOL 10114828-11108LF

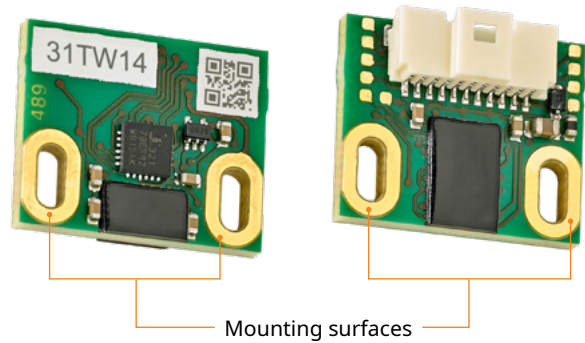
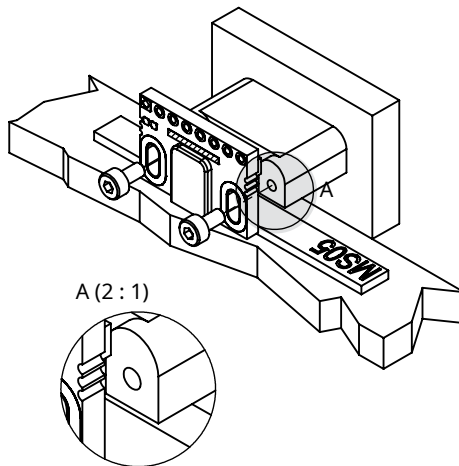
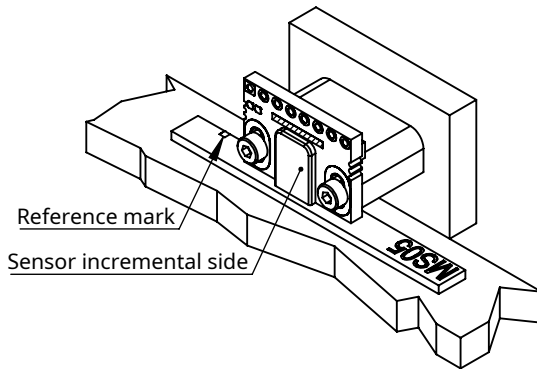


## RLC2IC through-hole pads



## Installation instructions

When mounting the RLC2IC, make sure that only the mounting surfaces of the PCB assembly are in contact with the mounting bracket. All other parts of the PCB assembly should maintain a minimum distance of 0.1 mm from other metal objects. All permissible distance and angle tolerances must be strictly complied according to the mounting instructions found at MSD01, MR01D01 or MR02D02 data sheets at [RLS Media center](#).



Images are for illustration purpose only. Valid for all versions.

### Position of installation holes

Recommended use of stainless steel, DIN912. For more information see **Table of recommended fastener tightening torques** at [RLS Media center](#).

**To avoid mechanical damage to the PCB assembly, do not use countersunk fasteners.**

- It is important that the space between the readhead and the magnetic scale is maintained over the entire measuring range.
- The magnetic encoder system must be used in accordance with the specified degree of protection. The following factors must be taken into account: IP protection class, operating temperature, external magnetic field, humidity level, mechanical load and EMC compatibility.
- The magnetic encoder system is sensitive to the external magnetic fields. The magnitude of the influence on the magnetic encoder system depends on the magnitude and direction of the external magnetic field. In particular, the rapidly changing stray magnetic fields affect the system and can alter its function. Magnetic field strength within 1 mT reduces the accuracy of the system. Field strengths greater than 1 mT will cause the system to malfunction and as a result the readhead will report an incorrect position. Magnetic field strengths greater than 25 mT will cause irreversible damage to the magnetic scale or ring and will have to be replaced.

# Technical specifications

## System data

|                                       |                     |   |
|---------------------------------------|---------------------|---|
| <b>Pole length</b>                    |                     | 2 mm  |
| <b>Maximum measuring length</b>       |                     | 50 m  |
| <b>System accuracy</b>                | Linear application  | $\pm 10 \mu\text{m/m}$ / $\pm 20 \mu\text{m/m}$ / $\pm 40 \mu\text{m/m}$  |
|                                       | MS05 magnetic scale | Different accuracy grades of MS05 magnetic scale available. Refer to MSD01 available at <a href="#">RLS Media center</a> .  |
|                                       | Rotary application  | <b>Axial:</b> Refer to MR01D01 available at <a href="#">RLS media center</a> .<br><b>Radial:</b> Refer to MR02D02 available at <a href="#">RLS media center</a> .         |
| <b>Hysteresis</b>                     |                     | $< 3 \mu\text{m}$ (at 0.3 mm ride height)   |
| <b>Repeatability (unidirectional)</b> |                     | $< 1 \mu\text{m}$   |
| <b>Reference mark</b>                 |                     | Unique / Periodic   |
| <b>Set-up time</b>                    |                     | $< 50 \text{ ms}$ (after power supply voltage is set in operating range)  |
| <b>Resolution</b>                     |                     | Max. 13 bit ( $\sim 0.244 \mu\text{m}$ ) For details refer to the <a href="#">Table of available resolutions</a> .  |
| <b>Maximum speed</b>                  | Linear application  | Refer to MSD01 available at <a href="#">RLS Media center</a> .  |
|                                       | Rotary application  | <b>Axial:</b> Refer to speed calculator available at <a href="#">RLS website</a> .<br><b>Radial:</b> Refer to speed calculator available at <a href="#">RLS website</a> . |

## Electrical data

|                                    |  |
|------------------------------------|--|
| <b>Power supply</b>                | 5 V $\pm 0.25 \text{ V}$ – voltage on readhead             |
| <b>Current consumption</b>         | $< 30 \text{ mA}$ without 120 $\Omega$ termination         |
|                                    | $< 130 \text{ mA}$ with 120 $\Omega$ termination           |
| <b>Reverse polarity protection</b> | Without reverse polarity protection.                       |
| <b>Maximum cable length</b>        | 10 m (Flex cable: 0.5 m ( $R \leq 0.75 \Omega/\text{m}$ )) |
| <b>Recommended wire gauge</b>      | Through-hole: 21 AWG to 30 AWG                             |

## Mechanical data

|                         |  |                       |
|-------------------------|--|-----------------------|
| <b>Mass</b>             | Through-hole   | 1.35 g                |
|                         | With connector   | $\sim 1.85 \text{ g}$ |
| <b>Connection types</b> | Molex 527451197, AMPHENOL 10114828-11108LF, Molex 5015681107, Through-hole |                       |

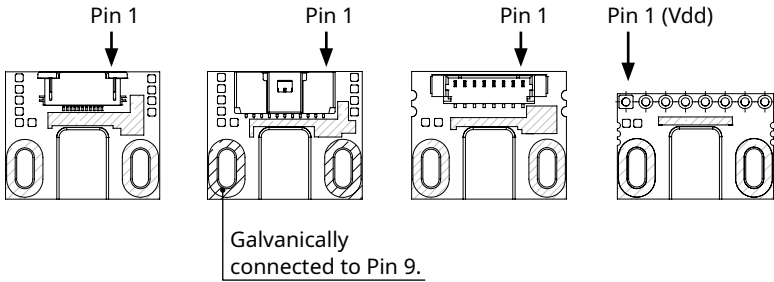
## Environmental data

|   |  |   |
|---|--|---|
| <b>Operating and storage temperature</b>        | With Molex 527451197                               | $-40 \text{ }^{\circ}\text{C}$ to $+85 \text{ }^{\circ}\text{C}$  |
|   | With Molex 5015681107 or AMPHENOL 10114828-11108LF | $-40 \text{ }^{\circ}\text{C}$ to $+105 \text{ }^{\circ}\text{C}$ |
|   | Through-hole design                                | $-40 \text{ }^{\circ}\text{C}$ to $+125 \text{ }^{\circ}\text{C}$ |
| <b>Vibrations (55 Hz to 2000 Hz)</b>            | 300 $\text{m/s}^2$ (IEC 60068-2-6)                 |   |
| <b>Shocks (6 ms)</b>                            | 300 $\text{m/s}^2$ (IEC 60068-2-27)                |   |
| <b>Humidity</b>                                 | 70 % non condensing                                |   |
| <b>External magnetic field during operation</b> | $< 1 \text{ mT}$                                   |   |
| <b>ESD immunity</b>                             | HBM, Class 2 $\pm 2 \text{ kV}$                    |   |

# Electrical connections



| Function            | Signal | Molex 527451197 | Molex 501568-1107 | AMPHENOL 10114828-11108LF | Through-hole |
|---------------------|--------|-----------------|-------------------|---------------------------|--------------|
| Power               | Vdd    | 1               | 1, 2              | 1                         | 1            |
|                     | GND    | 2, 10           | 3, 4              | 2                         | 8            |
| Incremental signals | A+     | 6               | 5                 | 4                         | 6            |
|                     | A-     | 7               | 6                 | 3                         | 7            |
|                     | B+     | 8               | 7                 | 5                         | 4            |
|                     | B-     | 9               | 8                 | 6                         | 5            |
| Reference signals   | Z+     | 3               | 10                | 8                         | 2            |
|                     | Z-     | 4               | 11                | 7                         | 3            |
| Cable shield        | -      | -               | 9                 | -                         | -            |
| N.C.                | -      | 5, 11           | -                 | -                         | -            |



In configurations without reference mark the Z+ and Z- outputs maintain constant voltage potential levels of RS422 interface.



## Output type

### Incremental, RS422

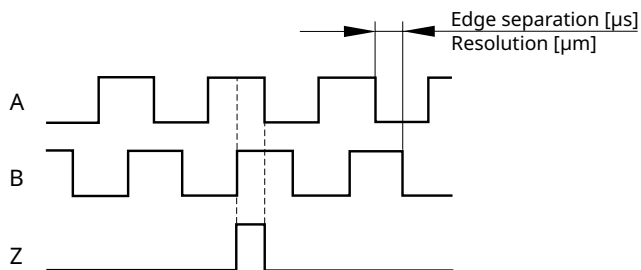
RLC2IC

#### Specifications

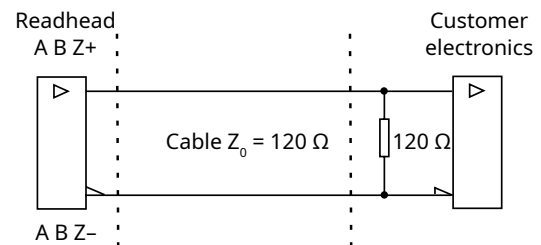
|                         |   |
|-------------------------|---|
| <b>Output signals</b>   | 3 square-wave signals A, B, Z and their inverted signals A-, B-, Z- |
| <b>Reference signal</b> | 1 or more square-wave pulse Z and its complementary pulse Z-        |
| <b>Signal level</b>     | Differential line driver according to EIA standard RS422            |
| <b>Permissible load</b> | $Z_0 \geq 120 \Omega$ between associated outputs                    |

### Timing diagram

Complementary signals not shown



### Recommended signal termination



### Positive direction

Digital output signals – A leads B

For more information see the MSD01, MR02D02 or MR01D01 data sheets at [RLS Media center](#).

## Part numbering

|  | RLC | 2 | IC | A | 13B | A | 00 | C | 18 |
|--|-----|---|----|---|-----|---|----|---|----|
| <b>Pole length</b><br>2 - 2 mm   |     |   |    |   |     |   |    |   |    |
| <b>Output type</b><br>IC - Incremental, RS422; 5 V   |     |   |    |   |     |   |    |   |    |
| <b>Option</b><br>A - Standard  |     |   |    |   |     |   |    |   |    |
| <b>Interpolation factor (Resolutions)*</b><br><b>13B</b> - 8192 (~0.244 µm) <b>09B</b> - 512 (~3.906 µm) <b>D10</b> - 100 (~20 µm)<br><b>12B</b> - 4096 (~0.488 µm) <b>D50</b> - 500 (~4 µm) <b>D08</b> - 80 (~25 µm)<br><b>11B</b> - 2048 (~0.976 µm) <b>D40</b> - 400 (~5 µm) <b>06B</b> - 64 (~31.25 µm)<br><b>2D0</b> - 2000 (~1 µm) <b>D32</b> - 320 (~6.25 µm) <b>D04</b> - 40 (~50 µm)<br><b>1D6</b> - 1600 (~1.25 µm) <b>08B</b> - 256 (~7.812 µm) <b>05B</b> - 32 (~62.5 µm)<br><b>10B</b> - 1024 (~1.953 µm) <b>D20</b> - 200 (~10 µm) <b>04B</b> - 16 (~125 µm)<br><b>1D0</b> - 1000 (~2 µm) <b>D16</b> - 160 (~12.5 µm) <b>03B</b> - 8 (~250 µm)<br><b>D80</b> - 800 (~2.5 µm) <b>07B</b> - 128 (~15.625 µm) |     |   |    |   |     |   |    |   |    |
| * For exact values see <b>Table of available resolutions</b> on the following page.  |     |   |    |   |     |   |    |   |    |
| <b>Minimum edge separation</b><br><b>K</b> - 0.07 µs (15 MHz) <b>E</b> - 4 µs (0.25 MHz)<br><b>A</b> - 0.12 µs (8 MHz) <b>F</b> - 5 µs (0.2 MHz)<br><b>B</b> - 0.5 µs (2 MHz) <b>G</b> - 10 µs (0.1 MHz)<br><b>C</b> - 1 µs (1 MHz) <b>H</b> - 20 µs (0.05 MHz)<br><b>D</b> - 2 µs (0.5 MHz)   |     |   |    |   |     |   |    |   |    |
| <b>Connector</b><br><b>00</b> - No connector, through-hole<br><b>12</b> - Connector Molex 5015681107<br><b>13</b> - Connector Molex 527451197<br><b>20</b> - Connector AMPHENOL 10114828-11108LF   |     |   |    |   |     |   |    |   |    |
| <b>Reference mark</b><br><b>A</b> - With unique reference mark<br>Magnetic scale or ring must be ordered with reference mark.<br><b>B</b> - No reference mark<br><b>C</b> - Periodic reference mark as per scale pitch (every 2 mm)<br>Reference periods correspond to pole length of magnetisation.<br>Magnetic scale or ring must be ordered with <b>no</b> reference mark.  |     |   |    |   |     |   |    |   |    |
| <b>Special requirements</b><br><b>00/18</b> - No special requirements (standard)   |     |   |    |   |     |   |    |   |    |

Encoder part numbers 00 or 18 are selected at the time of production based on material availability.  
This does not affect the fit/form/function of the encoder. Please contact [sales@rls.si](mailto:sales@rls.si) at the time of order.

Not all part number combinations are valid. Please refer to the table of available combinations on the next page for available options.

## Table of available combinations

| Series | Pole length | Output type | Option | Interpolation factor | Minimum edge separation           | Connector         | Reference mark | Special requirements |
|--------|-------------|-------------|--------|----------------------|-----------------------------------|-------------------|----------------|----------------------|
| RLC    | 2           | IC          | A      | xxx*                 | K / A / B / C / D / E / F / G / H | 00 / 12 / 13 / 20 | A / B / C      | 00 / 18              |
|        |             |             |        | 04B                  | A / B / C / D / E / F / G / H     |                   | B / C          |                      |
|        |             |             |        | 03B                  | B / C / D / E / F / G / H         |                   |                |                      |

\* Please check the table below for available interpolation factors.

For the part numbering of the MS incremental magnetic scale or the MR radial and axial incremental magnetic ring, refer to data sheets MSD01, MR02D02 and MR01D01 at **RLS Media Center**.

## Available resolutions

Table of available resolutions

| Part number | Pole length [mm] | Interpolation factor | Resolution [μm] |
|-------------|------------------|----------------------|-----------------|
| 13B         | 2                | 2 <sup>13</sup>      | 0.244140625     |
| 12B         |                  | 2 <sup>12</sup>      | 0.48828125      |
| 11B         |                  | 2 <sup>11</sup>      | 0.9765625       |
| 2D0         |                  | 2000                 | 1               |
| 1D6         |                  | 1600                 | 1.25            |
| 10B         |                  | 2 <sup>10</sup>      | 1.953125        |
| 1D0         |                  | 1000                 | 2               |
| D80         |                  | 800                  | 2.5             |
| 09B         |                  | 2 <sup>9</sup>       | 3.90625         |
| D50         |                  | 500                  | 4               |
| D40         |                  | 400                  | 5               |
| D32         |                  | 320                  | 6.25            |
| 08B         |                  | 2 <sup>8</sup>       | 7.8125          |
| D20         |                  | 200                  | 10              |
| D16         |                  | 160                  | 12.5            |
| 07B         |                  | 2 <sup>7</sup>       | 15.625          |
| D10         |                  | 100                  | 20              |
| D08         |                  | 80                   | 25              |
| 06B         |                  | 2 <sup>6</sup>       | 31.25           |
| D04         |                  | 40                   | 50              |
| 05B         |                  | 2 <sup>5</sup>       | 62.5            |
| 04B         |                  | 2 <sup>4</sup>       | 125             |
| 03B         |                  | 2 <sup>3</sup>       | 250             |

Resolutions calculation

$$\text{Resolution } [\mu\text{m}] = \frac{\text{Pole length } [\mu\text{m}]}{\text{Interpolation factor}} = \frac{2000}{\text{Interpolation factor}}$$

$$\text{Resolution [ppr]} = \frac{\text{Resolution [cpr]}}{4} = \frac{\text{Pole number}^* \times \text{Interpolation factor}}{4}$$

\*See pole numbers in the MR01D01 or MR02D02 data sheet at **RLS Media center**.

# Accessories



Cable assembly  
**ACC054**



Cable assembly  
**ACC055**



Cable assembly  
**ACC056**



Cable assembly  
**ACC057**



USB encoder interface  
**E201-9Q**

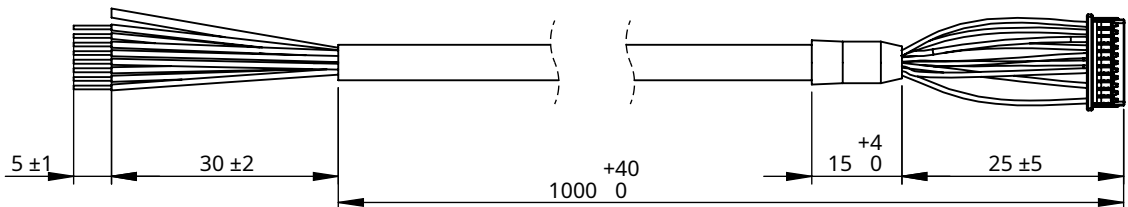


Cable assembly  
**ACC058**

## ACC054

| Part number | Length | Cable connector   | RLC2IC connector  | Termination  |
|-------------|--------|-------------------|-------------------|--------------|
| ACC054      | 1 m    | Molex 501330-1100 | Molex 501568-1107 | Flying leads |

Dimensions in mm.



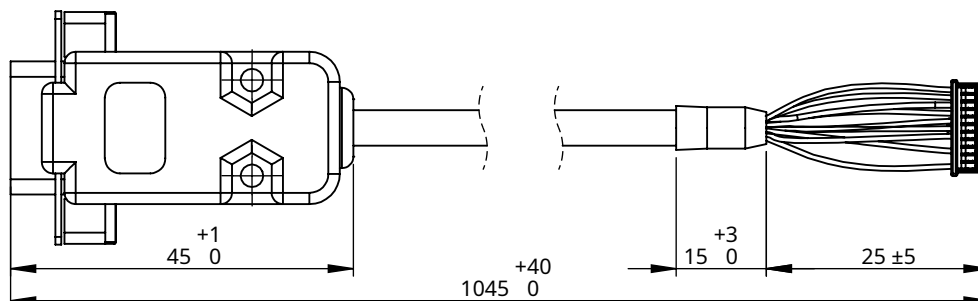
| Flying leads |            |
|--------------|------------|
| Wire number  | Wire color |
| 1            | Brown      |
| 2            | White      |
| 3            | Green      |
| 4            | Yellow     |
| 5            | Blue       |
| 6            | Red        |
| 7            | Shield     |
| 8            | Pink       |
| 9            | Grey       |

| Molex 501330-1100 |                      |        |
|-------------------|----------------------|--------|
| Pin number        | Signal               | Color  |
| 1                 | V <sub>IN</sub> +5 V | Brown  |
| 2                 | V <sub>IN</sub> +5 V | NC     |
| 3                 | GND                  | White  |
| 4                 | GND                  | NC     |
| 5                 | A+                   | Green  |
| 6                 | A-                   | Yellow |
| 7                 | B+                   | Blue   |
| 8                 | B-                   | Red    |
| 9                 | Shield               | Black  |
| 10                | Z+                   | Pink   |
| 11                | Z-                   | Grey   |

## ACC055

| Part number | Length | Cable connector   | RLC2IC connector  | Termination    |
|-------------|--------|-------------------|-------------------|----------------|
| ACC055      | 1 m    | Molex 501330-1100 | Molex 501568-1107 | DB-9 connector |

Dimensions in mm.



**DB-9 male connector  
(plastic housing)**

| Pin number | Wire color |
|------------|------------|
| 1          | Shield     |
| 2          | Pink       |
| 3          | Blue       |
| 4          | Green      |
| 5          | Brown      |
| 6          | Grey       |
| 7          | Red        |
| 8          | Yellow     |
| 9          | White      |

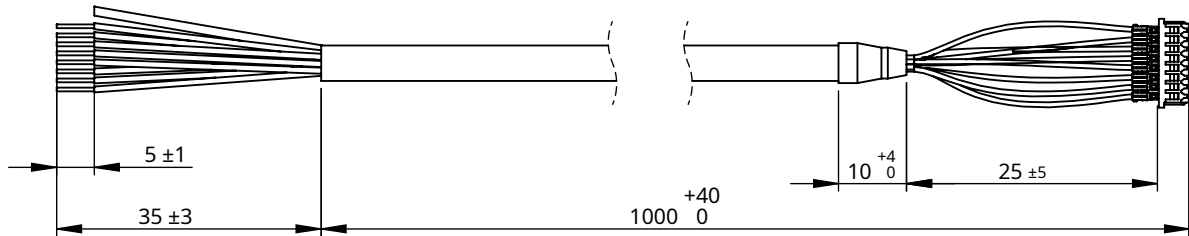
**Molex 501330-1100**

| Pin number | Signal               | Wire color |
|------------|----------------------|------------|
| 1          | V <sub>IN</sub> +5 V | Brown      |
| 2          | V <sub>IN</sub> +5 V | NC         |
| 3          | GND                  | White      |
| 4          | GND                  | NC         |
| 5          | A+                   | Green      |
| 6          | A-                   | Yellow     |
| 7          | B+                   | Blue       |
| 8          | B-                   | Red        |
| 9          | Shield               | Black      |
| 10         | Z+                   | Pink       |
| 11         | Z-                   | Grey       |

ACC056

| Part number | Length | Cable connector           | RLC2IC connector          | Termination  |
|-------------|--------|---------------------------|---------------------------|--------------|
| ACC056      | 1 m    | Amphenol 10114826-00008LF | Amphenol 10114828-11108LF | Flying leads |

Dimensions in mm.



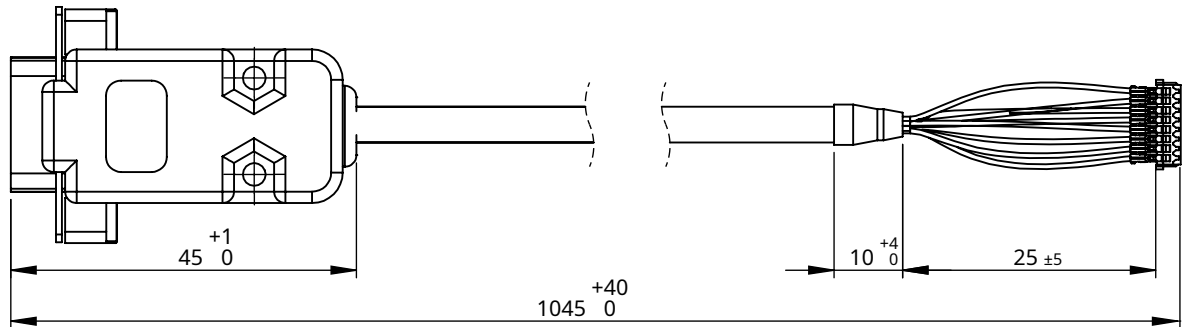
| Flying leads |            |
|--------------|------------|
| Wire number  | Wire color |
| 1            | Brown      |
| 2            | White      |
| 3            | Yellow     |
| 4            | Green      |
| 5            | Blue       |
| 6            | Red        |
| 7            | Grey       |
| 8            | Pink       |
| 9            | Shield     |

| Amphenol 10114826-00008LF |                       |            |
|---------------------------|-----------------------|------------|
| Pin number                | Signal                | Wire color |
| 1                         | V <sub>dd</sub> (5 V) | Brown      |
| 2                         | GND                   | White      |
| 3                         | A-                    | Yellow     |
| 4                         | A+                    | Green      |
| 5                         | B+                    | Blue       |
| 6                         | B-                    | Red        |
| 7                         | Z-                    | Grey       |
| 8                         | Z+                    | Pink       |

## ACC057

| Part number | Length | Cable connector           | RLC2IC connector          | Termination    |
|-------------|--------|---------------------------|---------------------------|----------------|
| ACC057      | 1 m    | Amphenol 10114826-00008LF | Amphenol 10114828-11108LF | DB-9 connector |

Dimensions in mm.



| DB-9 male connector<br>(plastic housing) |            |
|--|------------|
| Pin number                               | Wire color |
| 1  | Shield     |
| 2  | Pink       |
| 3  | Blue       |
| 4  | Green      |
| 5  | Brown      |
| 6  | Grey       |
| 7  | Red        |
| 8  | Yellow     |
| 9  | White      |

| Amphenol 10114826-00008LF |                       |            |
|---------------------------|-----------------------|------------|
| Pin number                | Signal                | Wire color |
| 1                         | V <sub>dd</sub> (5 V) | Brown      |
| 2                         | GND                   | White      |
| 3                         | A-                    | Yellow     |
| 4                         | A+                    | Green      |
| 5                         | B+                    | Blue       |
| 6                         | B-                    | Red        |
| 7                         | Z-                    | Grey       |
| 8                         | Z+                    | Pink       |

## Cable assemblies

| Part number | Length | Cable connector | RLC2IC connector         | Termination   |
|-------------|--------|-----------------|--------------------------|---------------|
| ACC058*     | 152 mm | –               | RLC2IC - Molex 527451197 | FFC connector |

\* 20 cycles at 4 mm bending radius.

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## Document issues

| Date         | Issue | Page         | Description   |
|--------------|-------|--------------|---|
| 29. 7. 2022  | 7     | General      | Dimension drawings amended, accessories added                               |
| 4. 10. 2022  | 8     | 10<br>12, 15 | Added Special requirement 00 in Part numbering<br>Removed ACC059            |
| 7. 4. 2023   | 9     | 6<br>8       | Installation instructions data added<br>Electrical connections data amended |
| 13. 9. 2023  | 10    | 10           | Menu (button) Max Speed Calculator added                                    |
| 13. 10. 2023 | 11    | 7            | Set-up time amended   |

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