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Technical information

The new LEIBINGER RAPID printer series

Version 1.4

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1 Introduction

The new high-speed printer series **Rapid** is designed for all print jobs for which the current version of the JET3up is not fast enough.

This document provides:

- Technical data
- Differences between the features and the possible applications of the available types of **RAPID**
- Overview on the available inks
- Important information about recommended encoders
- Overview on the differences regarding the spare parts

Important Information

There are several significant differences between the JET3up and the printers of the RAPID series. The differences affect parts of the printer as well as service procedures.

It is highly recommended thoroughly checking the manuals and the accessories catalogue for the differences between the JET3up and the JET3 RAPID series.

The following list gives an overview about the parts that are different for the RAPID series in comparison to the JET3up:

- Controller board
- Parts of the Printhead (please see details in accessories catalog)
- Ink valve (VV)

Regarding service and adjustment procedures the main differences are:

- Hydraulic settings
- Ink jet adjustments

The differences are described in the manuals that come together with the printers.

There are extracts of the manuals in the addendum of this document.

2 Technical data

There are three types of the **RAPID** available:

- RAPID Universal
- RAPID Highspeed
- RAPID Wire

2.1 Overview

Type	RAPID Wire	RAPID Highspeed	RAPID Universal
Maximum printing speed	1000 m/min	800 m/min	Up to 30% faster than the JET3up
Characters per second*	5830 128 kHz oscillator 3x7 tower font	5600 128 kHz oscillator 5x5 font	4635 128 kHz oscillator 7x5 font
Oscillator frequency	128 / 115 kHz	128 / 115 kHz	128 / 115 kHz
Nozzle size	50 µm / 55 µm Please see ink list in the appendix for details	50 µm / 55 µm Please see ink list in the appendix for details	50 µm / 55 µm Please see ink list in the appendix for details
Available fonts	3x7 tower 4x5 5x5 7x5*	3x7 tower 4x5 5x5 7x5*	Same fonts as JET3up Up to 32 dots
Print head dimensions			
Available inks	Please see appendix for a detailed ink list	Please see appendix for a detailed ink list	Please see appendix for a detailed ink list
Possible substrates	Please see ink list in the appendix for details about substrates	Please see ink list in the appendix for details about substrates	Please see ink list in the appendix for details about substrates
Pressured air required	Yes. 20 l/min	Yes. 20 l/min	No. Optional available.

*The characters per second value depends on the font and the oscillator frequency. Based on a standardized printout. **The 128 kHz oscillator is not available for each ink/font combination!**

**Only available with 50 µm nozzle

2.2 Font - Font height – Font width – Stroke distance – Speed

RAPID Wire

Font	Height [mm]	Recommended character width [mm]	Recommended stroke distance [mm]	Speed [m/min] drop frequency	
				115 kHz	128 kHz
3x7	1,5 – 2,0	2,0 - 4,0	0,30 – 0,58	521 - 988	580 - 1100
4x5*	1,5 – 2,0	1,4 – 2,5	0,25 – 0,52	341 - 719	380 - 800
7x5**	2,0 – 2,2	1,4 – 2,5	0,25 – 0,52	216 - 449	240 - 500

RAPID Highspeed

Font	Height [mm]	Recommended character width [mm]	Recommended stroke distance [mm]	Speed [m/min] drop frequency	
				115 kHz	128 kHz
3x7	1,5 – 2,4	2,0 – 4,0	0,3 – 0,58	521 - 988	580 - 1100
4x5*	0,9 – 2,4	0,9 – 2,5	0,2 – 0,52	234 - 719	260 - 800
7x5**	2,2 – 2,6	1,4 – 2,5	0,25 – 0,52	216 - 449	240 - 500

*there is also a 5x5 font available. With the 5x5 the maximum speed is a bit lower

**Only available with 50 μm nozzle

RAPID Universal

Same fonts as JET3up with print styles up to 32 dots. Recommended printing distance: 15mm.

3 Features and applications

The three types of printers of the RAPID series provide different features and they are designed for different kinds of applications.

3.1 Overview about features and applications

Type	RAPID Wire	RAPID Highspeed	RAPID Universal
Features	• 1000 m/min maximum printing speed in high quality • A special print head provides a very short distance between print head and substrate. • There are several approved inks especially for cable applications available	• Up to 800 m/min maximum printing speed in high quality • There are several approved inks available for various applications and substrates	• Up to 30% faster than the JET3up • There is a broad range of approved inks available for various applications and substrates • There are the same fonts available as for the JET3up
Applications	• Cable/wire marking and printing • High speed printing on substrates that are adapted to the special print head	• High speed printing with a maximum print height of 2,5 mm.	• JET3up applications that require higher production speeds especially if there is a 2- or 3-line print out required. E.g. filling systems or bottling plants.
Restrictions	• There is a smaller range of approved inks available than for the JET3up • There are only three fonts available: ○ 3x7 tower ○ 4x5 ○ 5x5 ○ 7x5* • The **diameter** of the substrate must not be larger than 5 mm.	• There is a smaller range of approved inks available than for the JET3up • There are only four fonts available: ○ 3x7 tower ○ 4x5 ○ 5x5 ○ 7x5* • The recommended **distance** between print head and substrate is 5 mm. Shorter distances bear the risk of contaminating the print head, larger distances may have a negative effect on the quality of the printouts.	• There is a smaller range of approved inks available than for the JET3up • For optimal results the recommended **distance** between print head and substrate 15 mm. Shorter distances bear the risk of contaminating the print head, larger distances may have a negative effect on the quality of the printouts.
*Only available with 50 μm nozzle			

3.2 Printing speed and the quality of printouts

Each printer type of the RAPID series could be used for production speeds up to 1000 m/min. However, the quality of the printouts would not be acceptable using the wrong printer for a certain speed.

Therefore, it is important to know which type of printer to select for which speed.

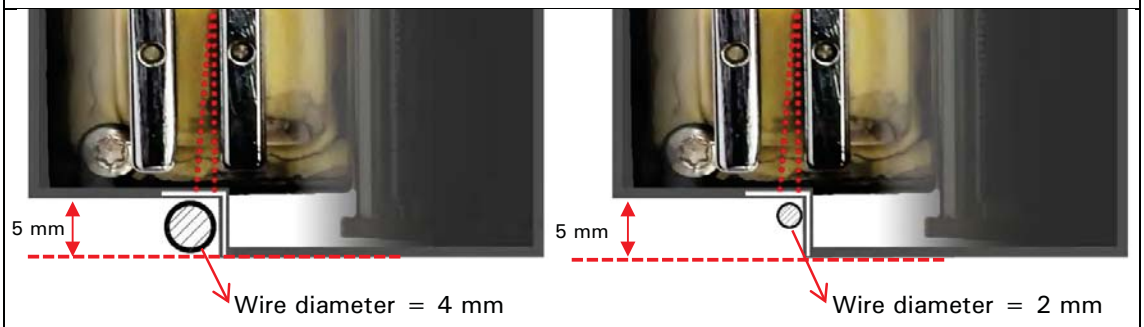
RAPID Wire

The RAPID Wire comes with a special print head that allows a nearly zero distance between print head and substrate. This makes it possible to work at the highest speeds.

The print head of the RAPID wire is designed especially for printing on wires. Nevertheless, the print head may also be used for all other kind of products as long as they fit to the special design of the print head.

Due to this design, the print head should only be used for substrates with a **diameter smaller than 5 mm**. For substrates with a larger diameter or thickness, it is recommended using the RAPID Highspeed or the RAPID Universal.

The print head of the RAPID Wire: designed for wire printing at high speeds



The illustrations show the special print head of the RAPID Wire printer with wires of different diameters. It is important to get the wire, respectively the print head, in a position that provides good print out results.

The closer the substrate is positioned to the outlet of the print head the better will be the quality of the print out at high speeds.

It has also to be considered that the diameter of the wire affects the position of the print out on the cable.

Rapid Highspeed

The RAPID Highspeed comes with the same print head technology as the RAPID Wire but with a different head cover. The headcover of the RAPID Highspeed is designed for high-speed applications that:

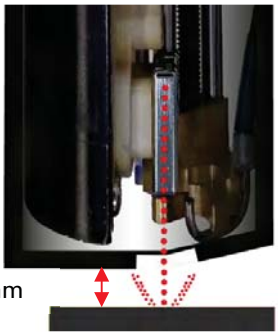
- require a larger distance between print head and head cover
- whereby the **recommended** distance is **5 mm**
- and/or for substrates that are not suitable for the RAPID Wire print head

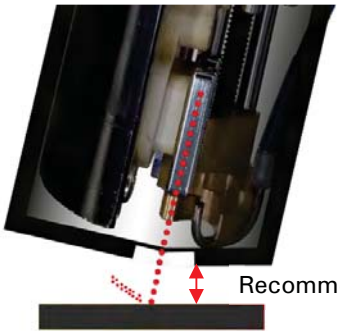
With the special design, it is possible to mount the print head in a slightly inclined position. This will prevent the printer from becoming contaminated by bursting ink drops.

Due to the larger distance between print head and substrate, the operation speed of the RAPID Highspeed is a bit lower than with the RAPID Wire.

Whereby the difference is not based on technical restrictions but on the quality of the printouts. Which means that the RAPID Highspeed may be operated at the same speed as the RAPID Wire but the quality of the print outs are not expected to be as good as they are with the RAPID Wire.

The print head of the RAPID Highspeed: The slightly angled surface allows an optimized mounting of the print head.





Ink drops that hit the surface of a substrate tend to burst in smaller drops and not all drops are absorbed by the substrate. When the print head is mounted vertically, the bursting ink drops may lead to a faster contamination of the print head.	With the angled surface of the outlet side of the print head, it is possible to mount the print head in a slightly inclined position. The ink drops will not hit the substrate at a 90° angle. Therefore, the bursting ink drops will take a direction away from the outlet, which will lead to less contamination of the print head.

Generally: the distance between print head and substrate should not be below 5 mm in order to avoid the contamination of the print head by rebounding ink drops. A larger distance may have negative effects on the quality of the printouts.

RAPID Universal

The RAPID Universal comes with the same print head as the JET3up. The main difference to the JET3up is the higher oscillator frequency of the RAPID Universal.

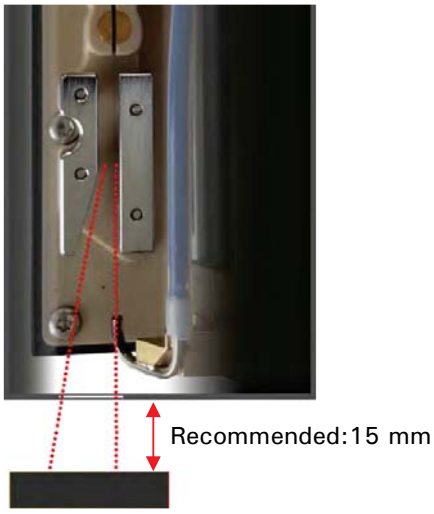
With an oscillator, frequency of up to 128 kHz the RAPID Universal allows a 30% faster operating speed than the JET3up with a 96 kHz oscillator frequency.

The RAPID Universal provides also the same fonts as the JET3up. Therefore, the higher operating speed is available not only for a special range of high-speed fonts but for the whole range of fonts.

If, for instance, a print job for the JET3up with a 32 dot high quality font allows a printing speed of 30 meter/minute, it will be possible to print the same job with the RAPID Universal at a speed of around 40 m/min.

In order to reach a good quality for the print outs at the faster speeds the recommended distance between print head and substrate is **15 mm.**

The print head of the RAPID Universal: From the dimensions, the print head is equivalent to the SK6 print head of the JET3up.



The print head works with the same range of fonts as the JET3up. Due to the higher operating speeds, the recommended distance between print head and substrate is **15 mm.**

Shorter distances bear the risk of contaminating the print head; larger distances may have a negative effect on the quality of the printouts.

3.3 Print samples

The following print samples are all created with 70-101 black ink on the different types of RAPID printers, at different speeds and with different printing parameters.

3.3.1 Print samples RAPID Wire

Not available

3.3.2 Print samples: RAPID Highspeed in comparison with RAPID Universal

The print sample show that with a 7x5 font the RAPID Highspeed has quality advantages compared with the RAPID Universal at speed higher than 200 m/min

7X5 JET3UP RAPID HIGHSPEED 200M/MIN	RAPID Highspeed - 200 m/min
7X5 JET3UP RAPID UNIVERSAL 200M/MIN	RAPID Universal - 200 m/min

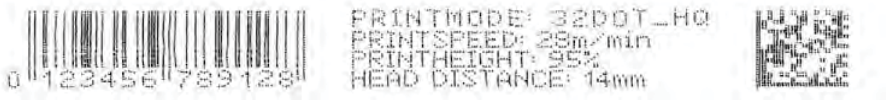
7X5 JET3UP RAPID HIGHSPEED 300M/MIN	RAPID Highspeed - 300 m/min
7X5 JET3UP RAPID UNIVERSAL 300M/MIN	RAPID Universal - 200 m/min

7X5 JET3UP RAPID HIGHSPEED 400M/MIN	RAPID Highspeed - 400 m/min
7X5 JET3UP RAPID UNIVERSAL 400M/MIN	RAPID Universal - 400 m/min

7X5 JET3UP RAPID HIGHSPEED 500M/MIN	RAPID Highspeed - 500 m/min
7X5 JET3UP RAPID UNIVERSAL 500M/MIN	RAPID Universal - 500 m/min

3.3.3 Print samples: RAPID Universal in comparison with JET3up – 2D codes

The print samples show that the RAPID Universal provides the same print quality as the JET3up but at a 30% higher production speed. The print outs of the RAPID Universal are a shade lighter than the print outs of the JET3up. However, a quality check of the 2-D code shows that the code has the highest readability level.

	**RAPID Universal** **55 µm nozzle** 28 m/min
	**JET3up** **60 µm nozzle** 20 m/min

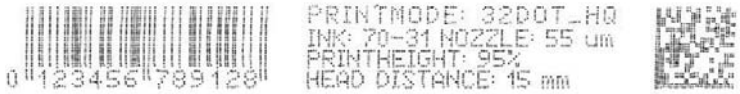
PQA (print quality assessment) for the two print outs

RAPID Universal at 95% print height	JET3up at 95% print height
DATAMATRIX 01234 >> PQA from Hand Held Products <<	DATAMATRIX 01234 >> PQA from Hand Held Products <<
DATA MATRIX ECC200: 16 x 16 modules in size	DATA MATRIX ECC200: 16 x 16 modules in size
Data Field: 12 data & 12 chks in 1 block(s) of GF(256)	Data Field: 12 data & 12 chks in 1 block(s) of GF(256)
X roughly = 0.017"	X roughly = 0.019"
[A] < Fixed Patterns: 0 module errors	[A] < Fixed Patterns: 0 module errors
[A] < Data Safety Margin = 83%	[A] < Data Safety Margin = 100%
[A] < Horizontal Print Growth = -3% of X	[A] < Horizontal Print Growth = -14% of X
[A] < Vertical Print Growth = +19% of X	[A] < Vertical Print Growth = -4% of X

The PQA does not show any significant differences between the code readability of the two printouts.

3.3.4 Print sample: RAPID Universal with 70000-00031 ink

The print samples show that even with a small drop ink like the 70000-00031 the print quality for barcodes with the RAPID Universal is still perfect.

	**RAPID Universal** **55 µm nozzle** 28 m/min

PQA (print quality assessment) for the print out

RAPID Universal at 95% print height
DATAMATRIX 01234 >> PQA from Hand Held Products <<
DATA MATRIX ECC200: 16 x 16 modules in size
Data Field: 12 data & 12 chks in 1 block(s) of GF(256)
X roughly = 0.018"
[A] < Fixed Patterns: 0 module errors
[A] < Data Safety Margin = 66%
[A] < Horizontal Print Growth = -3% of X
[A] < Vertical Print Growth = +10% of X

The PQA does shows the highest readability for the print outs of a RAPID Universal with the small-drop-ink 70000-00031. The smaller nozzle size combined with a small-drop-ink has no significant effects on the Print Quality Assessment (PQA).

3.3.5 Print sample: RAPID Wire and Rapid Highspeed cable printouts

The following example show the print out quality of the RAPID Wire and Rapid Highspeed printers at 800 m/min and 1000 m/min printing speed.


Printout RAPID Wire / 1000 m/min / 3x7 tower font/ full printout

Printout RAPID Wire / 1000 m/min / 3x7 tower font / details

Printout RAPID Highspeed / 800 m/min / 5x5 font/ full printout

Printout RAPID Highspeed / 800 m/min / 5x5 font / details

4 Available inks

For technical reason it is not possible to use the full range of LEIBINGER inks for high-speed printing.

Using an ink that is not approved for high-speed printing may result in printouts of dissatisfying quality!

Additionally an ink that is not approved may cause serious issues by ink contaminations of the print head!

4.1 Different ink ranges for different printers

The following table shows the inks available, sorted by the type of printer.

INK	JET3up RAPID Wire		JET3up RAPID Highspeed		JET3up RAPID Universal	
	50µm	55µm	50µm	55µm	50µm	55µm
70-030					✓	✓
70-031					✓	✓
70-101					✓	✓
70-106	✓*)	✓*)	✓	✓	✓	✓
70-115	✓*)	✓*)	✓	✓	✓	✓
70-120	✓	✓**)	✓	✓**)	✓	✓**)
70-126			✓	✓	✓	✓
70-134	✓	✓	✓	✓	✓	✓
70-139**)			✓	✓	✓	✓
72-102			✓	✓	✓	✓
76-101	✓	✓	✓	✓	✓	✓
78-101**)			✓	✓	✓	✓

*) Limitations regarding the cleaning intervals

**) Limitation regarding the maximum printing speed (115 kHz)

5 RAPID Wire and Highspeed: The print head ventilation

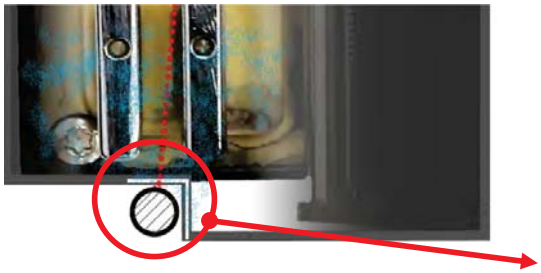
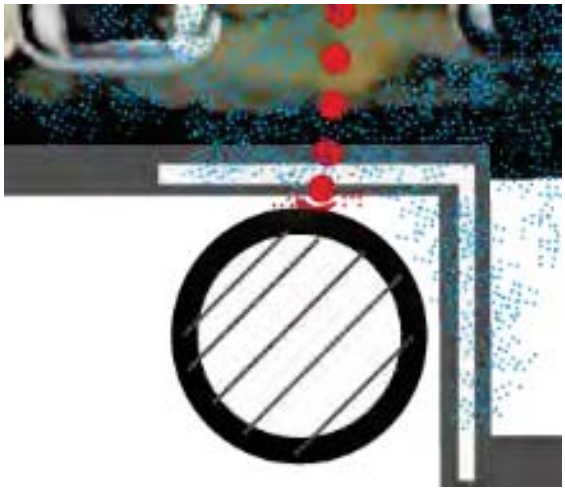
The RAPID Wire and the Rapid Highspeed printers are equipped with a print head ventilation. The print head ventilation ensures longer cleaning intervals and reduces the risk of condensation within the print head.

5.1 Basics about the functionality

The print head of the RAPID Wire and Highspeed printer has to be mounted at a distance between nearly zero und 5 mm to the substrate. This close installation provides the shortest trajectories for ink droplets. This is the basic requirement for a fast and precise print out. However, it also bears the risk of contaminating the print head by bursting ink droplets.

With the head ventilation there is a constant air stream at the outlet of the print head that works like a protective shield against the remains of ink droplets that burst on the surface of the substrate.

Example: print head ventilation with the RAPID Wire

	
The print head of the RAPID Wire during the printing process. The ink jet is illustrated as a series of red droplets. With the RAPID Wire the distance between the substrate, normally a cable, and the print head is nearly zero.	The illustration shows an enlargement of the print head. The red ink droplets burst on the surface of the substrate, causing smaller droplets that are bouncing back in the direction of the outlet of the print head. The compressed air of the head ventilation is illustrated as blue droplets. With the slight over pressure in the print head, the compressed air prevents the intrusion of ink droplets into the print head.

5.2 Technical details

The RAPID Wire and the Rapid Highspeed printers are equipped with a connector for compressed air. The connector is located on the back panel of the hydraulic cabinet.

Connector for compressed air

Technical data

Maximum input pressure:	10 bar (145.035 psi)
Factory preset for the pressure control:	1,4 bar (20.305 psi)
Recommended flow:	20 l/min

Warning

Operation is only permissible with clean, dry, oil-free and filtered compressed air (Filtering 8 µm).

Using compressed air that does not meet these requirements may cause serious damages to the print head.

Attention

Make sure that there is a permanent compressed air supply!

- The printer does not monitor the permanent compressed air supply!
- There will be no warning in case the permanent compressed air supply fails!

6 Information about encoders

Regarding the encoders that are used for a high-speed application, there are two limitations to be considered. The first one is the maximum output frequency of the encoder and the other one is the maximum input frequency of the **X1** encoder input interface of the printer.

6.1 Basics

Regarding speed measuring the RAPID printers work with internal speed as well as with an external encoder.

An external encoder has the advantage that a varying production speed would not affect the quality of the print out. Additionally the printer would recognize a stop of the production line.

Nevertheless, using an encoder for high-speed printing requires a careful selection of the encoder.

6.2 The resolution and the output frequency of the encoder

The resolution of an encoder indicates the number of pulses per rotation.

An encoder, for instance, with a resolution of **2.500** indicates that the encoder provides 2.500 pulses per rotation of the encoder axis.

Normally there is a measuring wheel with a circumference mounted on the axis of the encoder. The given circumference of the measuring wheel and the resolution of the encoder results in the pulses per mm.

$$\frac{number\ of\ pulses\ per\ rotation}{Circumference\ measuring\ wheel\ [mm]} = pulses/mm$$

If, for instance, the circumference of the measuring wheel is 200 mm the resolution is:

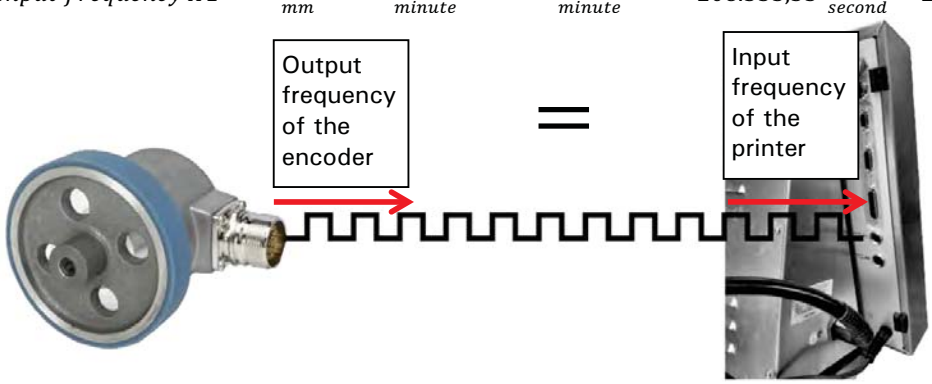
$$\frac{2.500}{200}\frac{pulses}{mm} = 12{,}5\ pulses/mm$$

In order to determine the output frequency of the encoder, which represents also the input frequency at the **X1** encoder interface of the printer, the resolution has to be multiplied with the actual production speed.

$$Input\ frequency\ X1 = \frac{pulses}{mm} * \frac{mm}{minute}$$

If, for instance, the production speed is 1000 m/min → 1.000.000 mm/min the input frequency is:

$$Input\ frequency\ X1 = \frac{12{,}5\ pulses}{mm} * \frac{1.000.000\ mm}{minute} = \frac{12.500.000\ pulses}{minute} = 208.333{,}33\ \frac{pulses}{second} = 208{,}33\ kHz$$



Important:

It is highly recommended thoroughly checking the technical specifications of the encoder that is used. An encoder with a high resolution leads to high output frequencies at high-speed operations.
Make sure that the encoder is able to manage such frequencies!

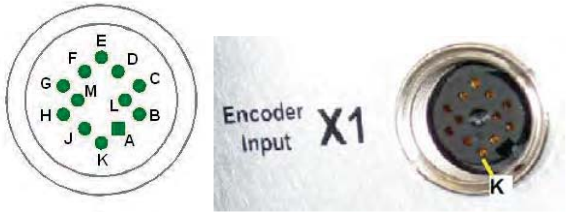
6.3 The specifications of the encoder input of the printer

The RAPID printer offers 3 different signal inputs:

- An input for RS422 signals
- An input for HTL signals
- An input for TTL signals

Each type of input has its own specifications regarding the voltage levels, the input resistance and the maximum frequency. For high-speed applications, the maximum input frequency is of particular importance.

Input specifications for interface X1 – Input for encoder signals



Pin	Description	Pin	Description
A	+5 V (max. 400 mA)	G	encoder channel /B RS422
B	GND	H	encoder channel A TTL (5V)
C	+24 V (1)	J	encoder channel B TTL (5V)
D	encoder channel A RS422	K	encoder channel A HTL (24V)
E	encoder channel /A RS422	L	encoder channel B HTL (24V)
F	encoder channel B RS422	M	PowerOn Option

Signal	Parameter	Value
RS422	Input level	Differential: +/-200mV Input voltage range: -0,3 to 5,5V
	Max. frequency	10 MHz
	Terminating resistance	120 Ohm
TTL	Input level high	2,4V to 5,5V
	Input level low	-0,5V to 0,7V
	Max. frequency	500 kHz
	Input resistance	1 MOhm
HTL	Input level high	12 to 28V
	Input level low	-0,5 to 3,5V
	Max. frequency	500 kHz
	Input resistance	3.3 kOhm

As the table shows, the RS422 input with 10 MHz allows the highest maximum input frequency.

The TTL and the HTL inputs are designed for a maximum frequency of 500 kHz.

Even encoders for high-speed applications cannot provide output frequencies higher than 350 kHz. Therefore, the inputs of the printer are not the limiting factor regarding the higher encoder frequencies during high-speed printing.

Make sure that the encoder is able to provide the output frequency that is required for the application!

6.4 Recommendations regarding the encoder / Printer combination for high-speed applications

Normally the limiting factor is the encoder. Even high-speed encoders do not provide output frequencies above 350 kHz. Therefore, the main reason for malfunctions with respect to the encoder/printer combination is either an inappropriate encoder or the operation of the encoder beyond its specifications.

When designing a high-speed application for a RAPID printer, the first step has to be the selection of an appropriate encoder!

The following chapter provides an example based on the shaft encoder from the LEIBINGER accessories catalogue.

6.5 Example for an encoder / printer combination

The encoder with the LEIBINGER article number **54-002352** K is designed for the use with LEIBINGER printers. The encoder has a TTL compatible RS 422 interface and a resolution of 2500 pulses/rotation.

The maximum number of revolutions permitted mechanically is 6.000 rotations per minute.

The maximum output frequency is 300 kHz.

At the maximum number of revolutions permitted mechanically the frequency at the output of the encoder is:

$$6000\,\frac{rotations}{minute} \times 2500\,\frac{pulses}{rotation} = 15.000.000\,\frac{pulses}{minute} = 250.000\,\frac{pulses}{second} = 250\,kHz$$

Therefore, at the maximum speed permitted mechanically the output frequency stays below the 300 kHz allowed.

How to calculate the actual output frequency

In order to calculate the actual number of revolutions per minute the following parameters are required:

- The resolution per rotation of the encoder
- The circumference of the measuring wheel that is used
- The maximum production speed

This example calculates with the following values:

- resolution per rotation of the encoder (article number 54-002352 K): **2.500 per rotation**
- Circumference of the measuring wheel: **200 mm**
- Maximum production speed: **1.000 m/minute** (or: **1.000.000 mm/minute)**

The first value to be calculated is the value for the pulses per mm:

$$\frac{2.500}{200}\,\frac{pulses}{mm} = \mathbf{12,5\,pulses/mm}$$

The next value to be calculated is the output frequency of the encoder:

$$Output\ frequency\ encoder = \frac{pulses}{mm} * \frac{mm}{minute}$$

$$Output\ frequency\ encoder = \frac{12{,}5\,pulses}{mm} * \frac{1.000.000\,mm}{minute} = 208.333{,}33\,\frac{pulses}{second} = \mathbf{208\,kHz}$$

The output frequency of **208 kHz** stays below the limit of 300 kHz. Therefore, it is possible to use the encoder with a measuring wheel whose circumference is **200 mm** at a speed of **1000 m/min**.

It is not recommended using encoders with a higher resolution than 2.500 pulses/rotation.
A higher resolution has no advantages and it bears the risk of malfunctions caused by an encoder output frequency that exceeds the value permitted for the encoder that is used.