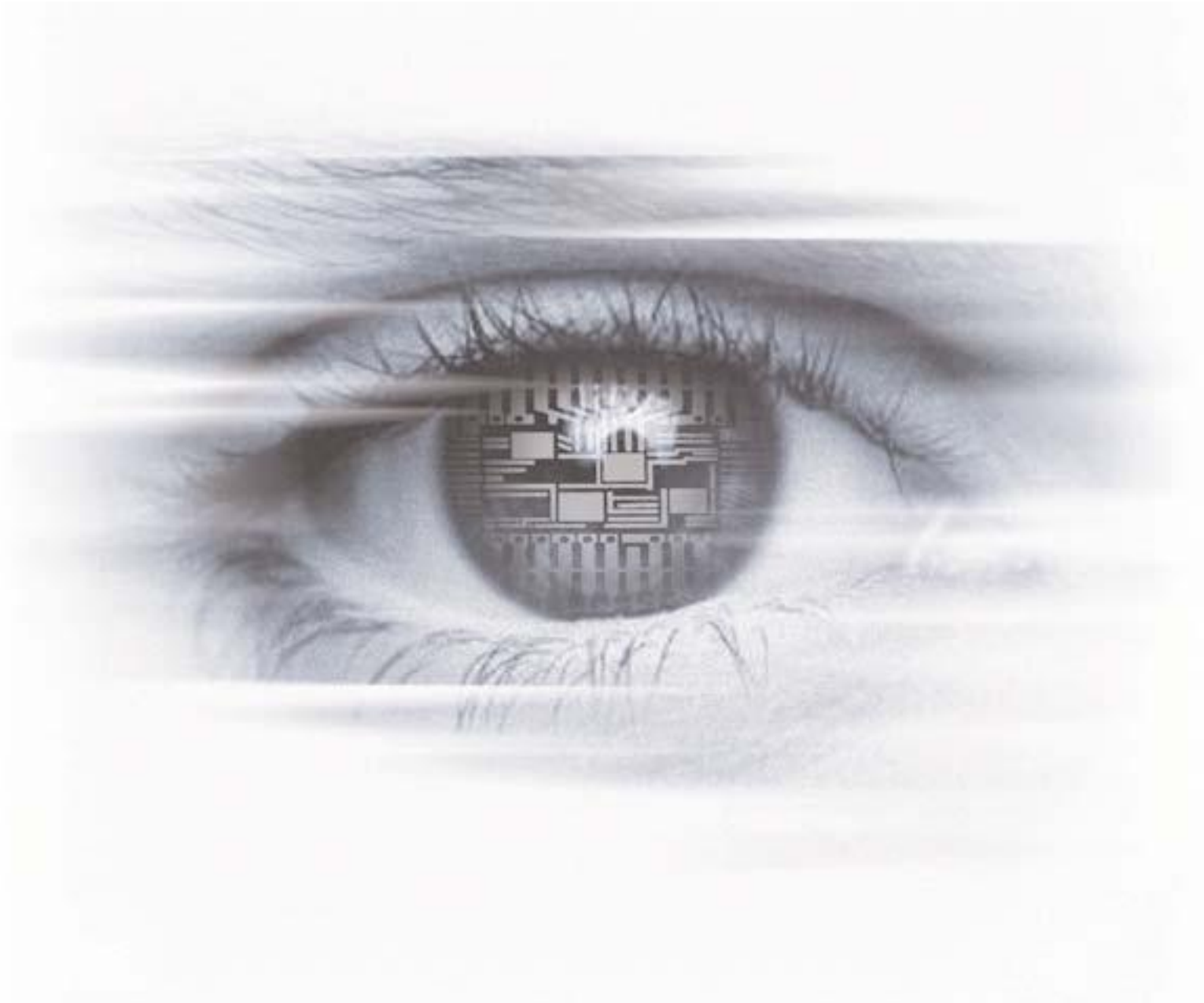
User Manual

Digipeater CLB26

CameraLink® Repeater



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Digipeater CLB26 User Manual

About Photonfocus

The Swiss company Photonfocus is one of the leading specialists in the development of CMOS image sensors and corresponding industrial cameras for machine vision.

Photonfocus is dedicated to making the latest generation of CMOS technology commercially available. Active Pixel Sensor (APS) and global shutter technologies enable high speed and high dynamic range (120 dB) applications, while avoiding disadvantages, like image lag, blooming and smear.

Photonfocus has proven that the image quality of modern CMOS sensors is now appropriate for demanding applications. Photonfocus' product range is complemented by custom design solutions in the area of camera electronics and CMOS image sensors.

Photonfocus is ISO 9001 certified. All products are produced with the latest techniques in order to ensure the highest degree of quality.

Contact

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Sales Offices

Photonfocus products are available through an extensive international distribution network; details of the distributor nearest to you can be found at www.photonfocus.com.

Further information

For further information on the products, documentation and software updates please see our web site www.photonfocus.com or contact our distributors.

Photonfocus reserves the right to make changes to its products and documentation without notice. Photonfocus products are neither intended nor certified for use in life support systems or in other critical systems. The use of Photonfocus products in such applications is prohibited.

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1 Introduction

The Digipeater CLB26 is designed to overcome problems with image processing systems in which distance is a limitation. A standard CameraLink® cable can be used to connect a camera to a frame grabber over distances of up to 10 m. It frequently occurs, however, that twice this length is required to feed signal cables through the trunking of automation systems. The Digipeater CLB26 regenerates all data signals, including the control and communication signals of the CameraLink® base version. Thus, standard 10 m cables can be used to bridge distances of 20 m with no problem. Even connection distances of 30 m can be achieved by using high-grade cables (e.g. 3M part number 14B26-SZLB-xxx-0LC). Application specific cables and non standard custom cables can be obtained from Photonfocus.

Fig. 1: Digipeater CLB28 front view

Two Digipeaters CLB26 can be used in parallel for cameras with CameraLink® medium interface (see Fig. 10). For CameraLink® full cameras please use the Digipeater CLF52.

2 Connections / Block diagram

Fig. 2 shows a block diagram of the Digipeater. Data from the camera are connected to Port 1. The regenerated data are transmitted on to the frame grabber from Port 2. The direction of the data flow is marked with arrows on the Digipeater case (see Fig. 1).

The de-jitter unit regenerates the PixelClock and enables the usage of long cables on the output port 2. The watchdog controls the transmitter for correct start when powering the device and restart after power interruptions. The serial communication interface is equipped with a fail save circuit to avoid communication error in all conditions, in particular in cases of cable brakes and short cuts.

The CameraLink® interface is based on the LVDS standard for data transmission. The CameraLink® interface standard is described in [CLS2004]. Information about the LVDS standard can be found in [LOM2004], [IPS2006] and [CLD2006]. These documents are available from the Photonfocus Homepage www.photonfocus.com.

It is important to understand that the CameraLink® interface is a high speed data transmission. The performance of the complete system depends on the high frequency performance of all components of the system.

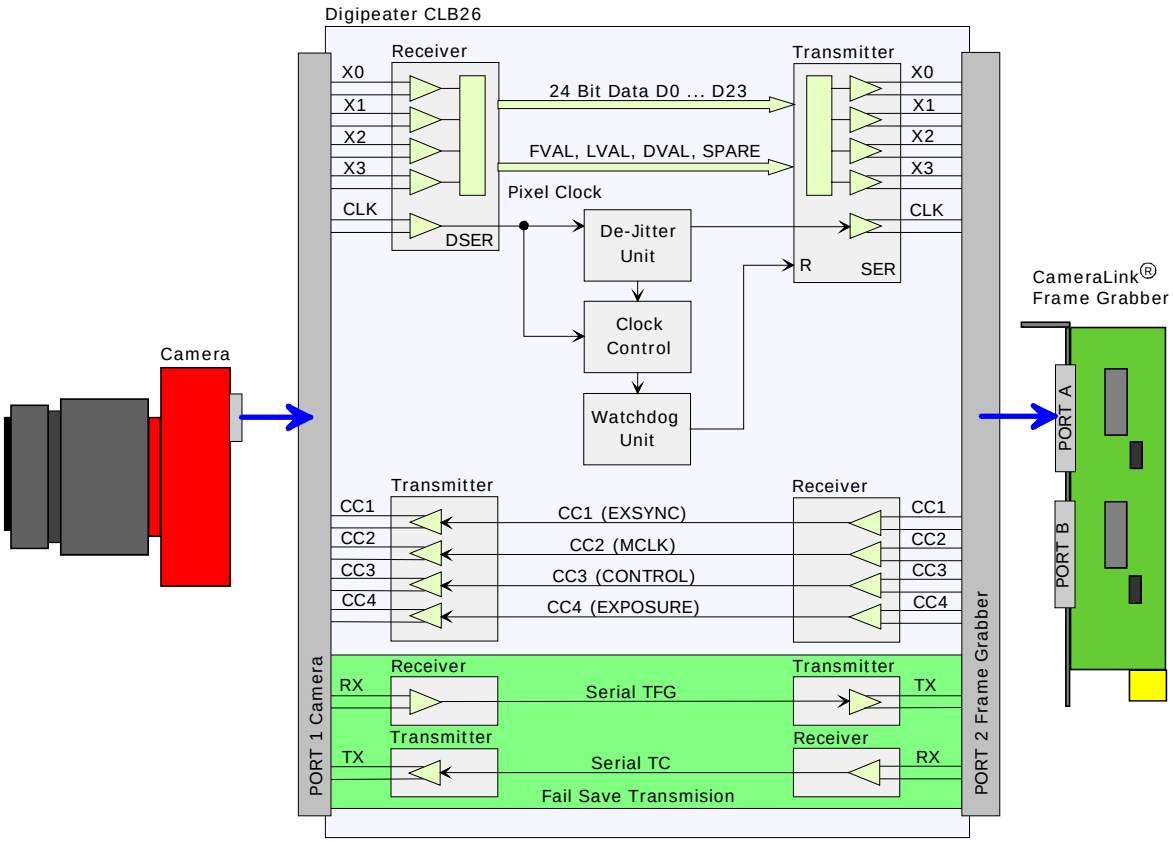

Fig. 2: Block diagram of the Digipeater

When installing cables in the vision system the cables have to be handled with extreme care to avoid destruction of the inner cable structure. Please do not apply extra force to the cables and mind the minimum bending radius. Otherwise the characteristic impedance of the cable will not be longer 100 Ohm and transmission errors or an interruption of the data transmission will occur. Cables for extreme conditions in drag chain and in robot applications can be ordered from Photonfocus.

At higher transmission distances it is important that the data signals meet the common voltage range of the receiver. An important aspect is the grounding concept for the complete vision system. Error currents which are caused by mismatches of the characteristic impedances of system components are compensated via the inner shield of the cable. Fig. 3 shows the grounding and wiring concept for the CameraLink® interface standard.

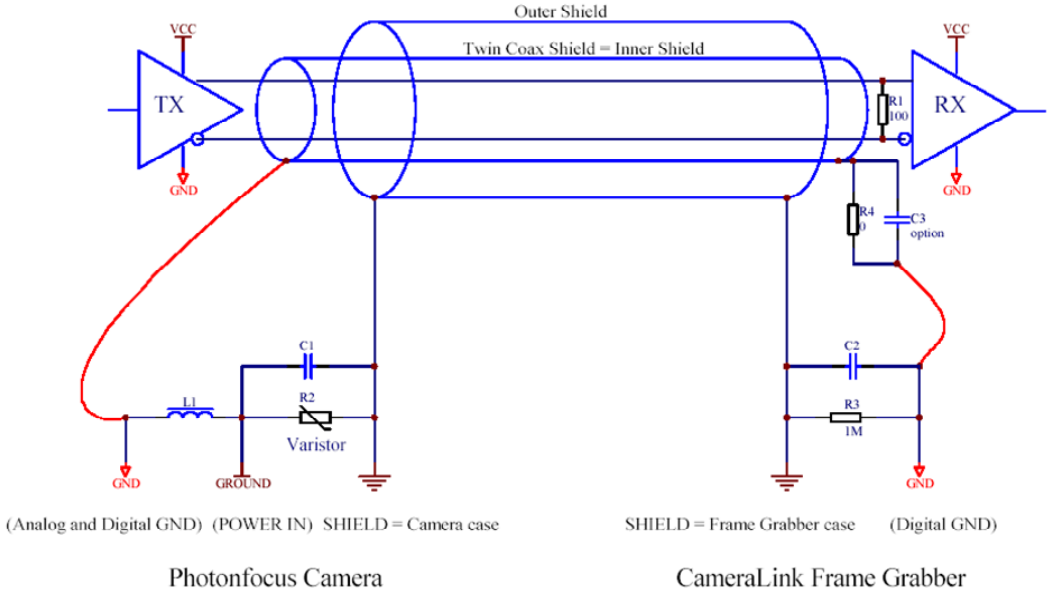

Fig. 3: Grounding concept for the CameraLink® interface

3 Performance of the complete system

The performance of the vision system is determined by the performance of the vision components at given bandwidth of the data transmission. The bandwidth of the CameraLink® interface is given by the bit depth of the camera, the number of taps and the transmission frequency (PixelClock frequency). The cable attenuation, the pair skews between the twisted pair cables in the CameraLink® cable and the clock jitter are the main limiting factors for the CameraLink® data transmission. To reach maximum transmission distances high performance cables have to be selected. Photonfocus uses high performance clock devices to reduce the clock jitter. To further enhance the jitter performance Photonfocus takes extreme care in the layout of the camera and repeater electronics.

Fig. 4 shows the maximum transmission distance for different cable cross-sections as a function of the transmission frequency. The basis for this diagram is a worst case analysis for the complete transmission path. Losses on the connectors and losses trough poor layout of camera and frame grabbers are not taken in considerations. Photonfocus designs cameras and repeaters for optimal performance.

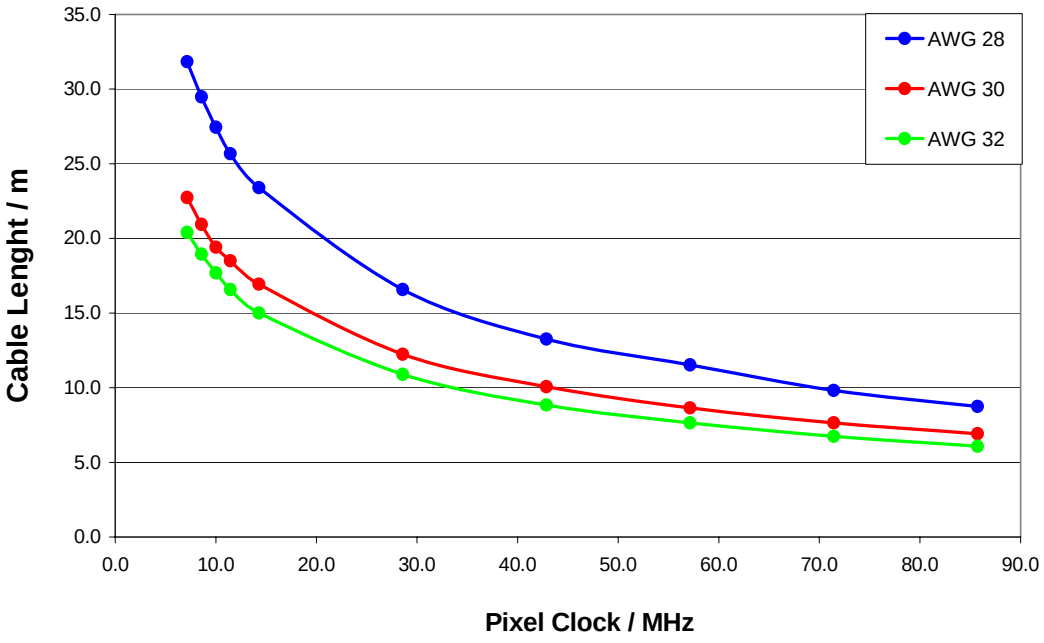

Fig. 4: Cable distance vs transmission frequency

In vision systems most often AWG28 CameraLink® cables are in use. Table 1 shows the distances for different configurations and transmission frequencies for an AWG28 CameraLink® standard cable. High performance cables, high flexible cables, cables for drag chains and robots are available from Photonfocus.

Table 1: Overview over the transmission length with optimal selected components and AWG 28 standard cable

Pixelclock	without CLB26	1 x CLB26	2 x CLB26	3 x CLB 26
20 MHz	20 m	40 m	60 m	80 m
33 MHz	15 m	30 m	45 m	60 m
40 MHz	13 m	26 m	39 m	52 m
66 MHz	10 m	20 m	30 m	40 m
80 MHz	9 m	18 m	27 m	36 m

4 CameraLink® Interface and Power Supply

The Digipeater has two sockets with signals for data transmission and the control of camera functions as well as one socket for external power supply. The pin assignments for the data and control signals are defined in the CameraLink® Standard [CLS2004]. Table 2 shows the pin assignments for Port 1 and Table 3 those for Port 2.

The subminiature circular connector Binder Series 712 is used for power supply. The order number for the Digipeater socket is 09-0408-00-03 (see **Table 4** and Fig. 5). Included with the Digipeater is a power supply plug, for which the order number is 99-0405-70-03.

The use of clean power supplies for the Digipeater is advised. High voltage spices cause data transmission errors. Photonfocus delivers audited power supplies for the Digipeater CLB26.

Table 2: Pin assignments for the MDR26 socket of the CameraLink® PORT 1 (Camera)

PIN	I/O	Name	Description
1	PW	SHIELD	Shield
2	I	N_CC4	Negative LVDS Input, Control signal CONTROL <not used>
3	I	P_CC3	Positive LVDS Input, Exposure control EXPOSURE
4	I	N_CC2	Negative LVDS Input, external clock for Slave mode MCLK
5	I	P_CC1	Positive LVDS Input, external Trigger signal EXSYNC
6	O	P_SERTOFG	Positive LVDS Output, Serial Communication from the Camera
7	I	N_SERTOCAM	Negative LVDS Input, Serial Communication to the Camera
8	O	P_XD3	Positive LVDS Output, CameraLink® Data D3
9	O	P_XCLK	Positive LVDS Output, CameraLink® clock
10	O	P_XD2	Positive LVDS Output, CameraLink® Data D2
11	O	P_XD1	Positive LVDS Output, CameraLink® Data D1
12	O	P_XD0	Positive LVDS Output, CameraLink® Data D0
13	PW	SHIELD	Shield
14	PW	SHIELD	Shield
15	I	P_CC4	Positive LVDS Input, Control signal CONTROL <not used>
16	I	N_CC3	Negative LVDS Input, Exposure control EXPOSURE
17	I	P_CC2	Positive LVDS Input, external clock for Slave mode MCLK
18	I	N_CC1	Negative LVDS Input, external Trigger signal EXSYNC
19	O	N_SERTOFG	Negative LVDS Output, Serial Communication from the Camera
20	I	P_SERTOCAM	Positive LVDS Input, Serial Communication to the Camera
21	O	N_XD3	Negative LVDS Output, CameraLink® Data D3
22	O	N_XCLK	Negative LVDS Output, CameraLink® clock
23	O	N_XD2	Negative LVDS Output, CameraLink® Data D2
24	O	N_XD1	Negative LVDS Output, CameraLink® Data D1
25	O	N_XD0	Negative LVDS Output, CameraLink® Data D0
26	PW	SHIELD	Shield
S	PW	SHIELD	Shield

Table 3: Pin assignments for the MDR26 socket of the CameraLink® PORT 2 (Frame grabber)

PIN	I/O	Name	Description
1	PW	SHIELD	Shield
2	O	N_XD0	Negative LVDS Output, CameraLink® Data D0
3	O	N_XD1	Negative LVDS Output, CameraLink® Data D1
4	O	N_XD2	Negative LVDS Output, CameraLink® Data D2
5	O	N_XCLK	Negative LVDS Output, CameraLink® clock
6	O	N_XD3	Negative LVDS Output, CameraLink® Data D3
7	I	P_SERTOCAM	Positive LVDS Input, Serial Communication to the Camera
8	O	N_SERTOFG	Negative LVDS Output, Serial Communication from the Camera
9	I	N_CC1	Negative LVDS Input, external Trigger signal EXSYNC
10	I	P_CC2	Positive LVDS Input, external clock for Slave mode MCLK
11	I	N_CC3	Negative LVDS Input, Exposure control EXPOSURE
12	I	P_CC4	Positive LVDS Input, Control signal CONTROL <not used>
13	PW	SHIELD	Shield
14	PW	SHIELD	Shield
15	O	P_XD0	Positive LVDS Output, CameraLink® Data D0
16	O	P_XD1	Positive LVDS Output, CameraLink® Data D1
17	O	P_XD2	Positive LVDS Output, CameraLink® Data D2
18	O	P_XCLK	Positive LVDS Output, CameraLink® clock
19	O	P_XD3	Positive LVDS Output, CameraLink® Data D3
20	I	N_SERTOCAM	Negative LVDS Input, Serial Communication to the Camera
21	O	P_SERTOFG	Positive LVDS Output, Serial Communication from the Camera
22	I	P_CC1	Positive LVDS Input, external Trigger signal EXSYNC
23	I	N_CC2	Negative LVDS Input, external clock for Slave mode MCLK
24	I	P_CC3	Positive LVDS Input, Exposure control EXPOSURE
25	I	N_CC4	Negative LVDS Input, Control signal CONTROL <not used>
26	PW	SHIELD	Shield
S	PW	SHIELD	Shield

Table 4: Pin assignments for the socket of the voltage supply connector

PIN	I/O	Name	Description
1	PW	VDD	+ 5 V voltage supply
2	PW	GND	Ground
3	PW	VDD2	Reserved

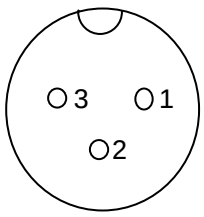

Fig. 5: Connector socket Nr. 09-0408-00-03 for the voltage supply

5 Mounting of the Digipeater

The Digipeater is delivered in an industry standard housing and can thus be integrated into cable trunking with no problem.
For wall or ceiling mounting, two additional attachment variants are offered. Fig. 6 shows the different attachment variants.

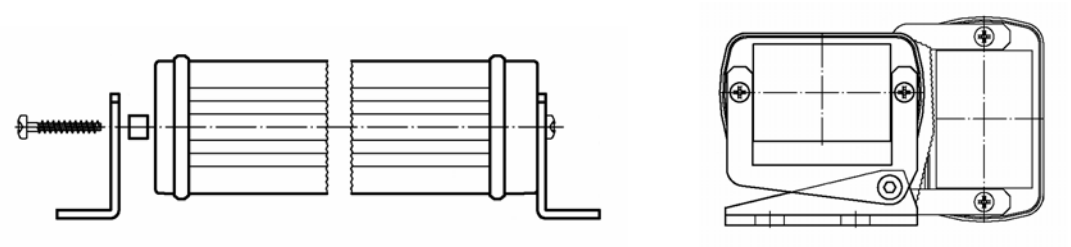

Fig. 6: Attachment variants (left: fix; right: adjustable)

6 Technical Data for the Digipeater CLB26

Table 5: Technical Specifications

Technical Data Digipeater CLB26	
Cable length	up to 15 m on both sides(*)
Digital interface	CameraLink®
Maximum Pixel clock frequency	80 MHz (cable length minimized)
Minimum Pixel clock frequency	20 MHz (cable length maximum)
Temperature range	0°C to 60°C
Configuration	CameraLink® Base Version CameraLink® Medium Version
Voltage	+5 ... +8V DC +/-10%
Power consumption	1W
Data connector	MDR26 (3M 10226-1210VE)
Power connector	Connector Series 712
Dimensions	57 mm x 36 mm x 107 mm
Weight	160 g

(*) If PixelClock < 30MHz;

6.1 Technical features

- ˝Power up˝ failsafe
- active clock regeneration with ˝zero skew˝
- automatic ˝standby mode˝ if camera is disconnected or not working
- ˝Hot Plug˝ functionality
- Fail save implementation of the communication channel between camera and frame grabber
- Flow trough design for easy implementation in vision systems

7 Configurations for Digipeaters

In this chapter configurations for Digipeater applications are presented. In the standard application a Digipeater is used between camera and frame grabber to extend the cable length (see Fig. 7). For longer distances multiple Digipeaters can be used in series. Table 1 gives an overview about the attainable distances in this application. Fig. 8 shows an example with two Digipeaters in series.

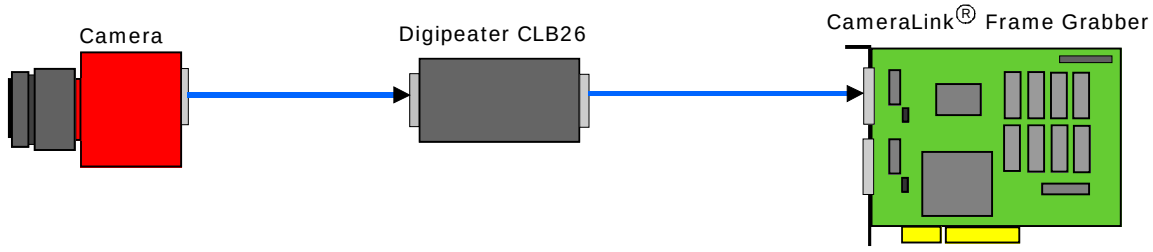

Fig. 7: Standard application for a Digipeater CLB26

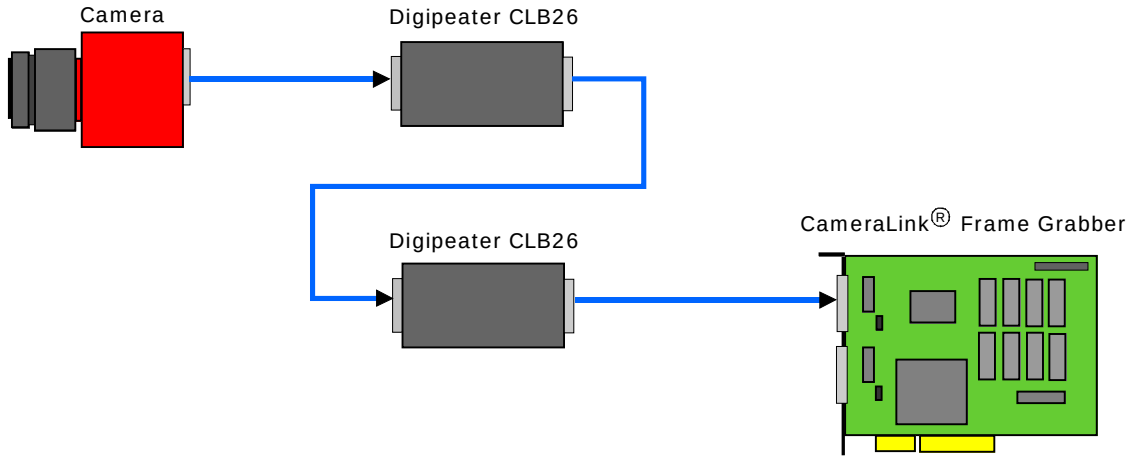

Fig. 8: Multiple applications for a Digipeater CLB26

The CameraLink® repeater can also be used in multi camera applications. This is shown in Fig. 9 for a two camera vision system. In this example the Digipeater is used in both data channels. An operation with only one Digipeater in a channel parallel to a data transmission without repeater is also possible.

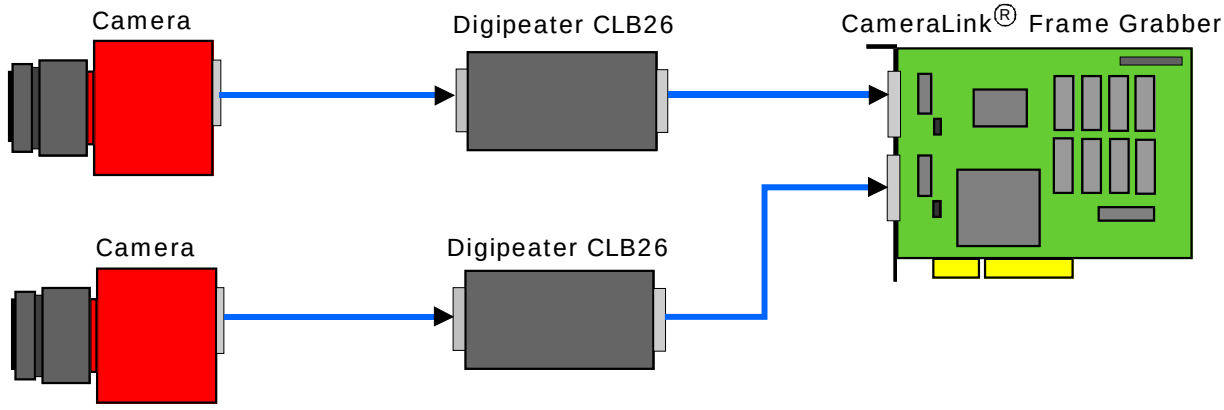

Fig. 9: Two Digipeater CLB26 in two camera vision system

Two Digipeaters can be used in parallel for CameraLink® Medium data transmission (see Fig. 10). In this application it is important to use the same cable length and cable sort in both of the CameraLink® Medium channels to reach maximum transmission distances.

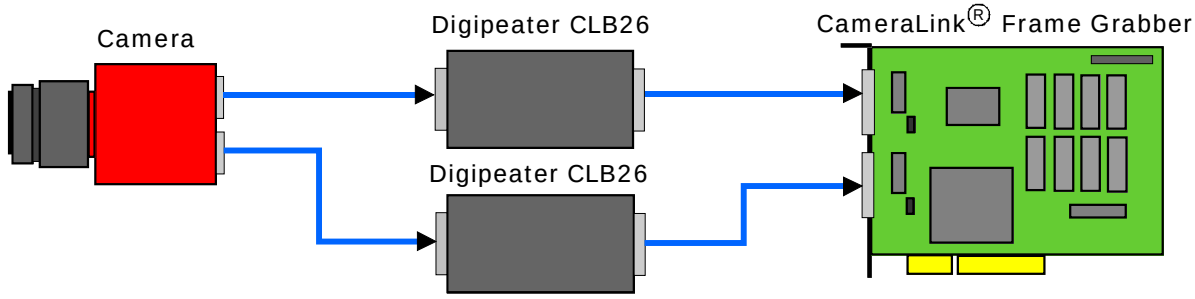

Fig. 10: Two Digipeater CLB26 in CameraLink® Medium data transmission

8 Applications

The CameraLink® repeater Digipeater CLB26 is used to bridge long transmission distances. Fig. 11 shows this application in a schematic drawing. In this vision system four cameras are used along a long assembly line. The cameras are connected via Digipeaters with the frame grabbers in the system control unit.

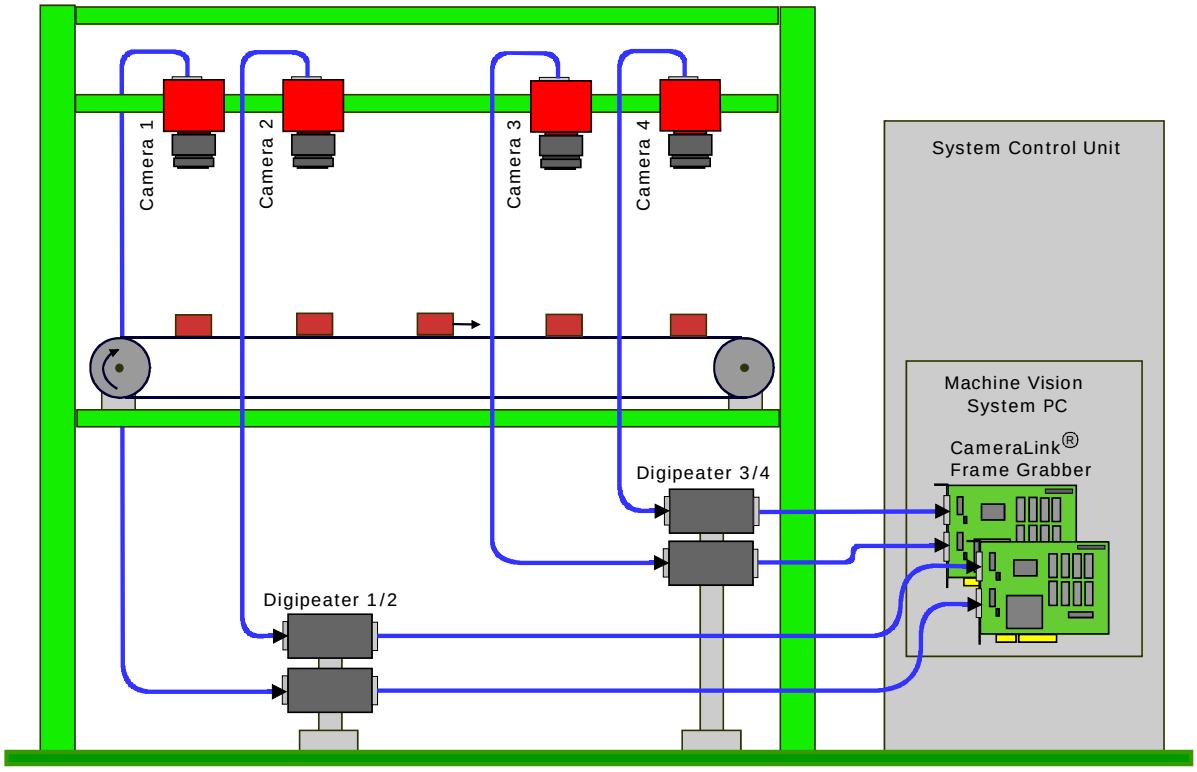

Fig. 11: Data transmission in a long mounting line

The Digipeater CLB26 can also be used for signal regeneration at cable feedthroughs or connections between cable sorts. This is often the case in robot applications where high flexible cables are in use on the robot itself and rigid cable are used to bridge the distance between the place of the robot and the system control unit.
Here the Digipeater enables the fast exchange of the highly stressed flexible data cables without the disassembly of the complete CameraLink® wiring. This saves time and cost in the maintenance of assembly lines. On the other hand reflections due to the mismatch of the characteristic impedances of the different cable sorts are avoided which enhances the quality and reliability of the data transmission.

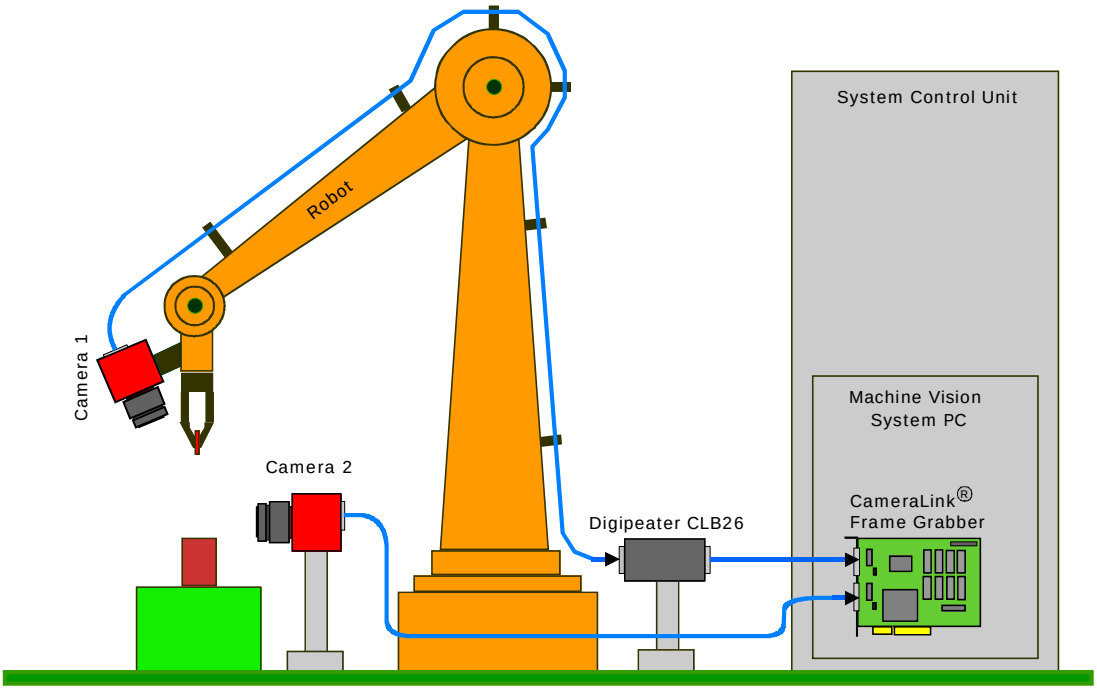

Fig. 12: Data transmission in a robot application

Fig. 12 shows a robot application with two cameras. One camera is mounted on the robot and connected via Digipeater with the frame grabber in the system PC. The other camera is direct connected with the machine vision PC.

The Digipeater can also be used to regenerate the image data in CameraLink® Mini Systems. There are often cables with AWG32 cross-section in use, which have a much higher attenuation than AWG28 cables. With the Digipeater one can overcome the distance limitations in these vision systems.

9 Ordering information

Table 6: Order items for Digipeater and accessories

Order item	Product description	Part number
Digipeater CLB26	CameraLink® Repeater	70 25 10.001
Digipeater power supply	Stabilized, linear 5V power supply (220 V/50 Hz) with 2 m cable and right-angled power plug	70 50 10.002
Digipeater mounting fix	Fixed mounting straps	70 25 20.001
Digipeater mounting adjustable	Adjustable mounting straps	70 25 20.002

10 Appendix A – CE Compliance Statement

CE Compliance Statement

We,

Photonfocus AG,
CH-8853 Lachen, Switzerland

declare under our sole responsibility that the following products

MV-D1024-28-CL-10, MV-D1024-80-CL-8, MV-D1024-160-CL-8

MV-D752-28-CL-10, MV-D752-80-CL-8, MV-D752-160-CL-8

MV-D640-33-CL-10, MV-D640-66-CL-10, MV-D640-48-U2-8
MV-D640C-33-CL-10, MV-D640C-66-CL-10, MV-D640C-48-U2-8

MV-D1024E-40, MV-D752E-40, MV-D750E-20 (CameraLink and USB2.0 models), MV-D1024E-80-CL-12, MV-D1024E-160-CL-12

MV-D1024E-PP01

MV2-D1280-640-CL-8

SM2-D1024-80

DS1-D1024-40-CL, DS1-D1024-40-U2,
DS1-D1024-80-CL, DS1-D1024-160-CL

Digipeater CLB26

are in compliance with the below mentioned standards according to the provisions of European Standards Directives:

EN 61 000 - 6 - 3 : 2001
EN 61 000 - 6 - 2 : 2001
EN 61 000 - 4 - 6 : 1996
EN 61 000 - 4 - 4 : 1996
EN 61 000 - 4 - 3 : 1996
EN 61 000 - 4 - 2 : 1995
EN 55 022 : 1994

Photonfocus AG, December 2007

11 Literature

11.1 Files on the web server www.photonfocus.com

[CLD2006] ChannelLink Design Guide, June 2006, National Semiconductor
See: Homepage National Semiconductor

[CLS2004] Specifications of the Camera Link Interface Standard for Digital Cameras and Frame Grabbers V1.1, January 2004
See: Homepage Photonfocus

[IPS2006] Interface Products Selection Guide, 4Q 2006, National Semiconductor
See: Homepage National Semiconductor

[LOM2004] LVDS Owner's Manual, A General Design Guide for National's Low Voltage Differential Signaling (LVDS) and Bus LVDS Products, 3 nd Edition Spring 2004 National Semiconductor
See: Homepage National Semiconductor

12 Tables

13 Figures

14 Revisions and State of Product development

14.1 Revisions

Table 7: Document revisions

REV	Changes	Date
1.0	First edition	02/12/02
1.1	Complete revision of the document	12/08/03
1.2	CE Compliance Statement integrated	28/07/04
1.3	document review and application information	28/01/08

15 Service information

15.1 Contact for product enquiries and quotations

For product enquiries and quotations, please contact one of our distributors in your area. A list of distributors can be found at:

www.photonfocus.com

15.2 Product information, documentation and software updates

www.photonfocus.com

15.3 Storage and Transport

During storage and transport, the digipeater should be protected against vibration, shock, moisture and dust. The original packing protects the digipeater adequately from vibration and shock during storage and transport. Please either retain this packing for possible later use or dispose of it according to local regulations.

15.4 Preparing for use

Remove the digipeater from its packing and ensure that it is complete and undamaged. If any damage has occurred during transport, please immediately contact the transport company and your distributor.

The digipeater is delivered with a 3-pole power plug. Ensuring that the maximum operating voltage is not exceeded, connect the digipeater to a suitable power supply.

16 Guarantee conditions

Guarantee claims
The manufacturer alone reserves the right to recognize guarantee claims. The guarantee will be rendered null and void in the event of unauthorized manipulation, mechanical damage or damage arising from inappropriate use or from mechanical or electrical modifications, especially soldering. The guarantee will also be invalidated if the apparatus is used for purposes for which it was not designed, if it is incorrectly connected or if it is not used according to the operating instructions.

Guarantee work
can only be assured and carried out by the manufacturer.

Repair time
will normally be a maximum of 10 working days for repairs to a device for which a legitimate guarantee claim is made.

Claims for damages
of all kinds, especially those arising from use, are excluded. Liability is limited, in all cases, to the value of our product.

In case of damage
If the equipment is defective, return it, in the original packing and with a copy of the receipt, to the following address:

Photonfocus AG
Bahnhofplatz 10
CH-8853 Lachen

Important: Include a written description of the fault as well as your full postal address. The equipment will be forwarded in your name to the service department and, in the event of a legitimate guarantee claim, returned to you without freight charges.

Safety hints
The apparatus conforms with approved electro-magnetic standards. Opening the apparatus is not permitted. Furthermore, all guarantee claims will be invalidated by inappropriate use. In all circumstances, the following should be noted:

- The apparatus may only be used for the purpose described.
- The apparatus is only suitable for indoor use. Protect it from moisture and heat.
- The permitted operating temperature range is 0°C to 60°C.
- Never attempt repairs yourself. Repairs may only be carried out by trained expert staff.
- Moreover, every piece of equipment is tested before delivery and has a guarantee symbol attached.
- For cleaning purpose, use only a dry soft cloth. Never use water or chemicals.