



**AMPB4-10G**  
**AEWA PRINT MANAGER BOARD**  
**HARDWARE USER GUIDE**

29.11.2022

Version 1.1

## Table of Contents

1	Overview .....	3
2	Block Diagrams .....	5
3	External Connections .....	6
4	Board Components.....	7
4.1	....SFP+ Connector (SFP3).....	7
4.1.1	10-Gigabit Ethernet with fiber-optic link .....	8
4.1.2	10-Gigabit Ethernet with CAT6/7 Cable .....	8
4.1.3	1-Gigabit Ethernet with CAT5/6 Cable.....	9
4.2	....Optical Interface for Printhead Boards (SFP1, SFP2).....	9
4.3	....Power Input Connector (SK1).....	11
4.4	....Encoder Input (SK5).....	11
4.5	....Optically Isolated Inputs (SK2) .....	12
4.6	....Optically Isolated Outputs (SK3).....	14
4.7	....Dropwatcher trigger output (SK4).....	14
4.8	....Daisy chain input (J2).....	15
4.9	....Daisy chain output (J3).....	15
4.10	..Extension connector (J4).....	15
4.11	..I/O Extension connector (J5).....	16
4.12	..IP-Address Switch (SW1).....	16
4.13	..IP-SEL Jumper (J7) .....	17
4.14	..Jumper (J8).....	18
4.15	..APMB4-10G LEDs.....	18
4.16	..Test Header (J6).....	19
4.17	..JTAG Connector (J1).....	19
4.18	..Test Points.....	19
5	Electrical and Thermal Characteristics.....	20
6	Mechanical Dimensions.....	21
7	Connectors and Cables.....	22
8	Ordering Information.....	24



# 1 Overview

APMB4-10G is the fourth generation of Print Manager Boards from AEWA. It is the core hardware of the AEWA Printing System and can drive up to 8 printhead boards. It connects to printhead boards via optical fiber cables which makes the data transfer immune to electromagnetic interference.

## Host Interface

APMB4-10G is currently capable of connecting to the host PC via 10-Gigabit or 1-Gigabit Ethernet.

## Performance

10-Gigabit Ethernet: 270 Mbytes/sec, uses TCP/IP offloading. 8Gb RAM.

1-Gigabit Ethernet: 103 Mbytes/sec, uses TCP/IP offloading. 8Gb RAM.

Optical interface to print heads: 600 Mbits/sec

Encoder: 80 Mbits/sec

## Printing Modes

Many different printing modes are implemented in standard APMB4-10G firmware including rotary spiral, rotary step, flatbed/multi pass, single pass band and continuous. Any other printing modes can be implemented with respect to customer requirements.

## Encoder Interface

Encoder index, external input, or internally generated trigger can be used as start print signal. Encoder interpolation logic enables multiplication and division of the encoder input so that it matches the desired resolution. It is also possible to disable the encoder interpolation logic.

APMB4-10G firmware also implements a virtual encoder which can be used on systems where a real encoder is not available. Its speed and direction are software programmable. Virtual encoder can be used with all printing modes.

## Daisy chaining



APMB4-10G can be run in master and slave modes. Slave board gets its encoder and start signals from the master or previous board and redirects it to the next board in the chain. Up to 64 APMB4-10G boards can be connected together in order to support systems where more than 8 printheads are used.

### **Printhead Control**

APMB4-10G enables to access all printhead settings including temperature set-point, current temperature, voltage control, fire waveform control and grey scale adjustment.

### **Firmware Update**

APMB4-10G firmware as well as the printhead board firmware can be updated automatically over host interface. Single function firmware update is also available in APMB software library.

### **Inputs Outputs**

Many isolated and non-isolated inputs and outputs are available on the board. Some of them have dedicated functions in standard firmware, but can be reprogrammed for special customer needs.

### **Power Input**

Single supply power input with over current protection, reverse polarity protection, surge current protection and transient overvoltage protection.

### **Security**

APMB4-10G FPGA Board is equipped with a 256-Bit AES Encryption for firmware copy protection.



## 2 Block Diagrams

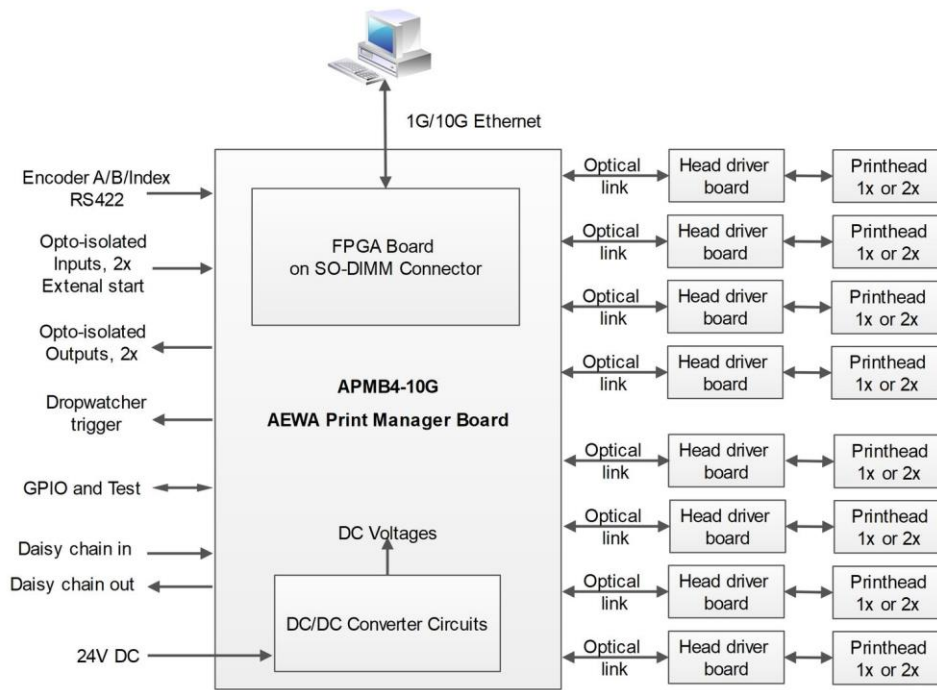


IMAGE 1 – APMB4-10G HARDWARE BLOCK DIAGRAM

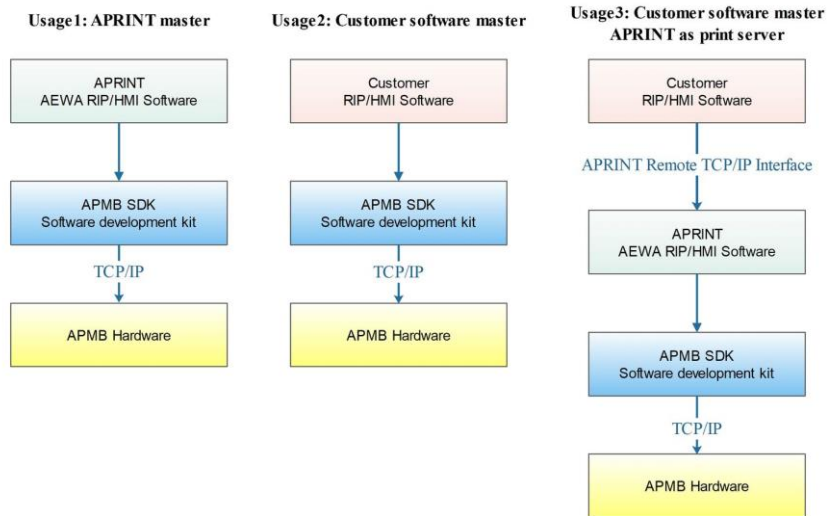


IMAGE 2 - APMB SOFTWARE BLOCK DIAGRAM



# 3 External Connections

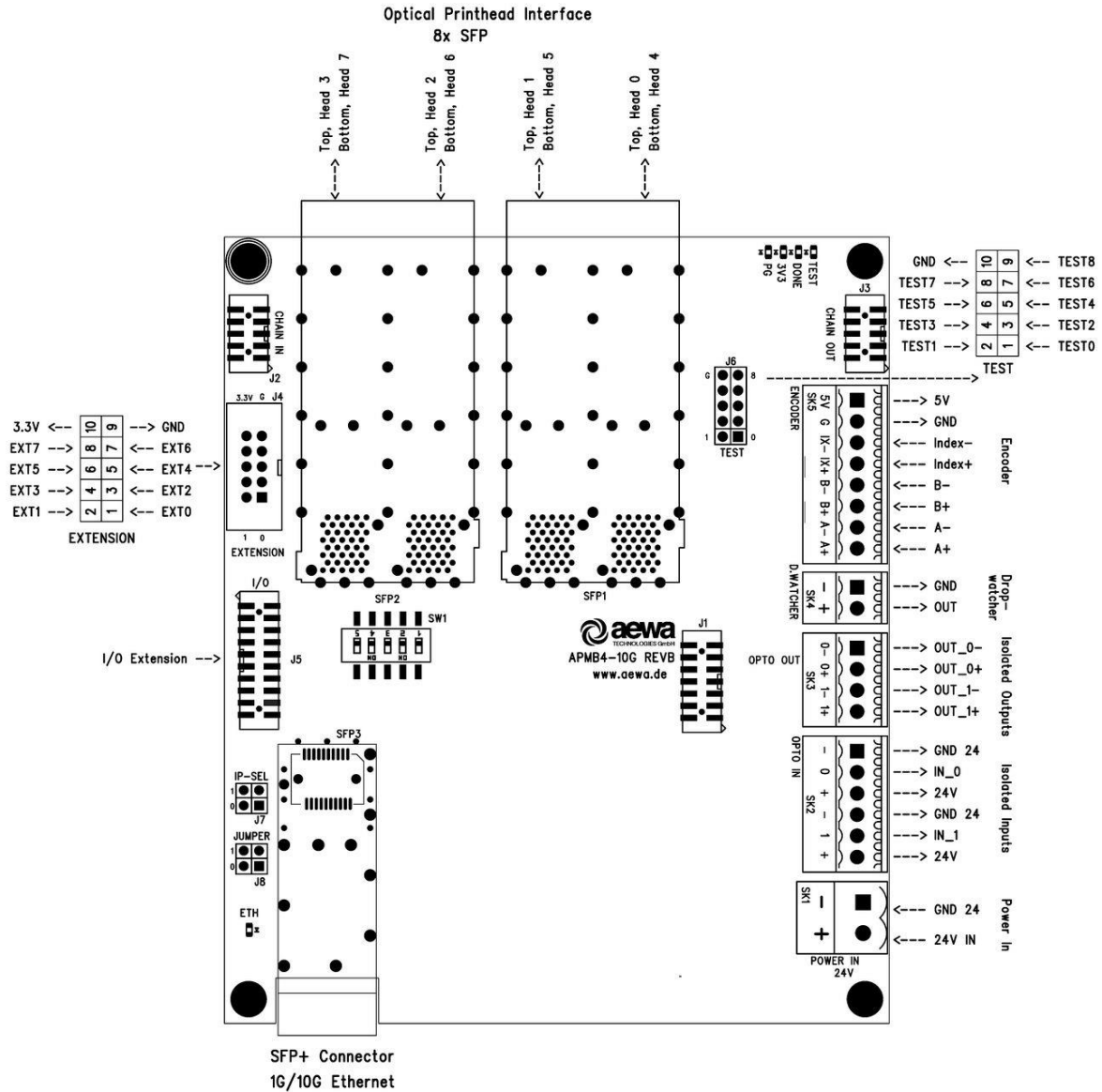


IMAGE 3 – APMB4-10G EXTERNAL CONNECTIONS



## 4 Board Components

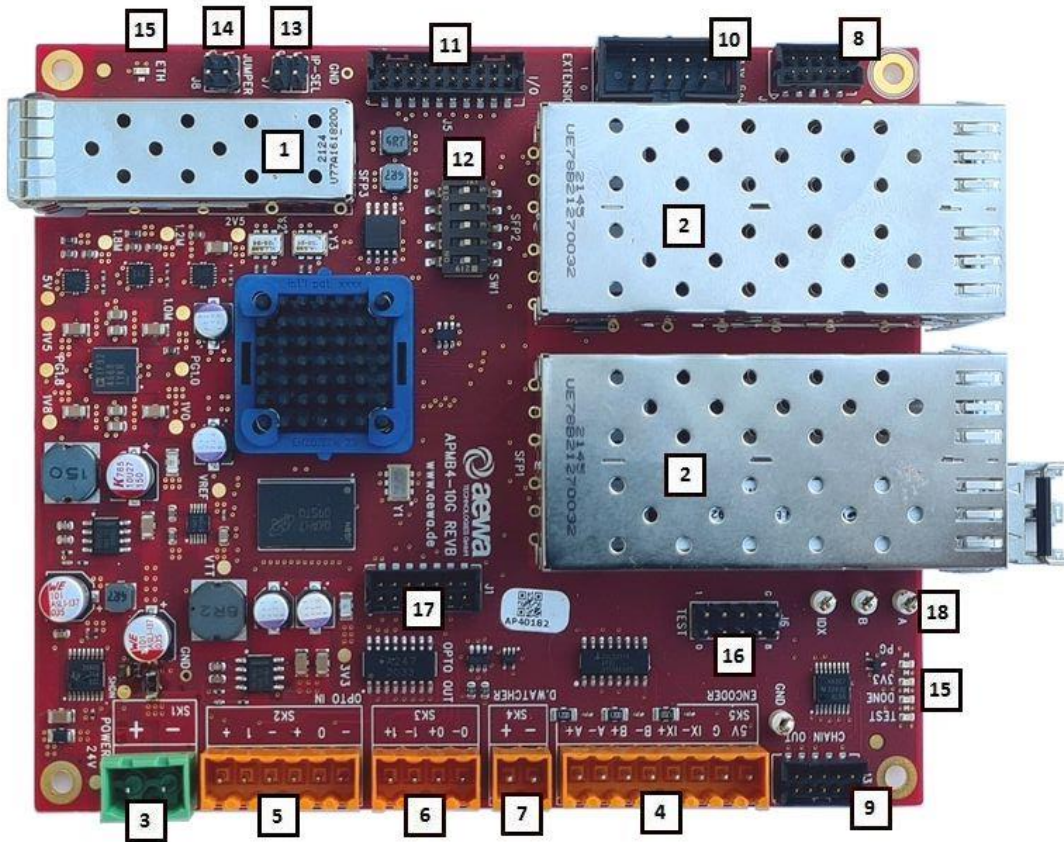


IMAGE 4 – APMB4-10G BOARD COMPONENTS

### 4.1 SFP+ Connector (SFP3)

APMB4-10G connects to the host PC through SFP3 Connector. It is a single port SFP+ connector. Different 1G or 10G SFP+ Ethernet modules can be attached. Following are some common configurations. Notice that 1G configuration needs a different firmware.

Speed	Module	Cable	Firmware Name
10G	10G SFP+	Optical fiber	apmb4_10g
10G	10G SFP+ RJ45	Copper, CAT6/7	apmb4_10g
1G	1G SFP RJ45	Copper, CAT5/6	apmb4_10g_1g

TABLE 1 - APMB4-10G CONFIGURATIONS





#### 4.1.1 10-Gigabit Ethernet with fiber-optic link

In this configuration, a 10G capable SFP+ Ethernet optical module is attached to the SFP3 connector. On the PC side a PCI Express or Thunderbolt to 10G Ethernet adapter/converter is needed.

APMB4 is successfully tested with following 10G adapters:

- Sonnet Solo 10G Thunderbolt 3 to SFP10+, LAN-Adapter
- Delock TN4010, PCI Express x4 Card SFP+ 10 Gigabit LAN
- ASUS XG-C100F, PCI Express x4 Card SFP+ 10 Gigabit LAN
- TRENDnet TEG-10GECSFP, PCI Express x4 Card SFP+ 10 Gigabit LAN

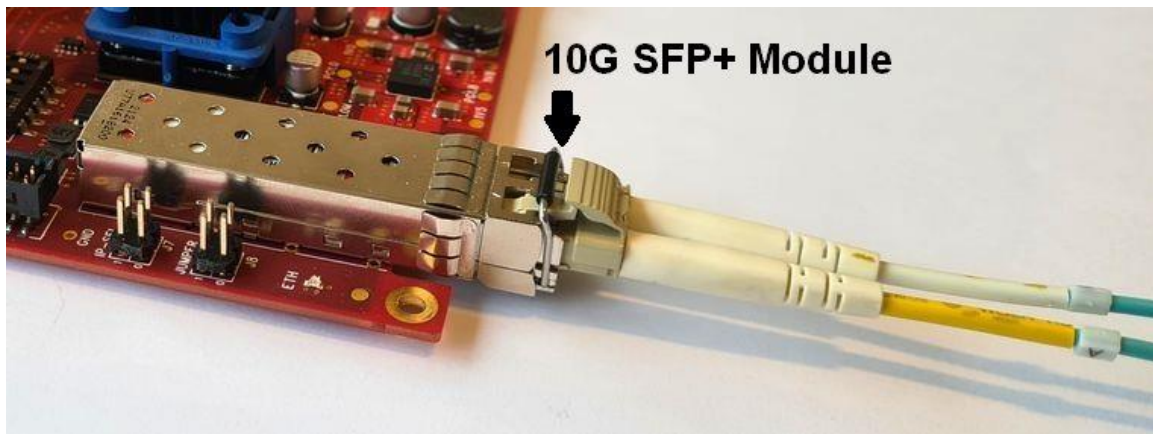


IMAGE 5 - 10-GIGABIT ETHERNET WITH FIBER-OPTIC LINK

#### 4.1.2 10-Gigabit Ethernet with CAT6/7 Cable

In this configuration, a 10G capable SFP+ Ethernet RJ45 module is attached to the SFP3 connector. RJ45 module can be connected to a 10G capable host through CAT6 or CAT7 cable.

**Note:** It is not recommended to use this configuration since RJ45 SFP+ modules generates too much heat which is also distributed to the APMB4-10G board. If used, the SFP+ cage need a heat-sink with sufficient air flow.





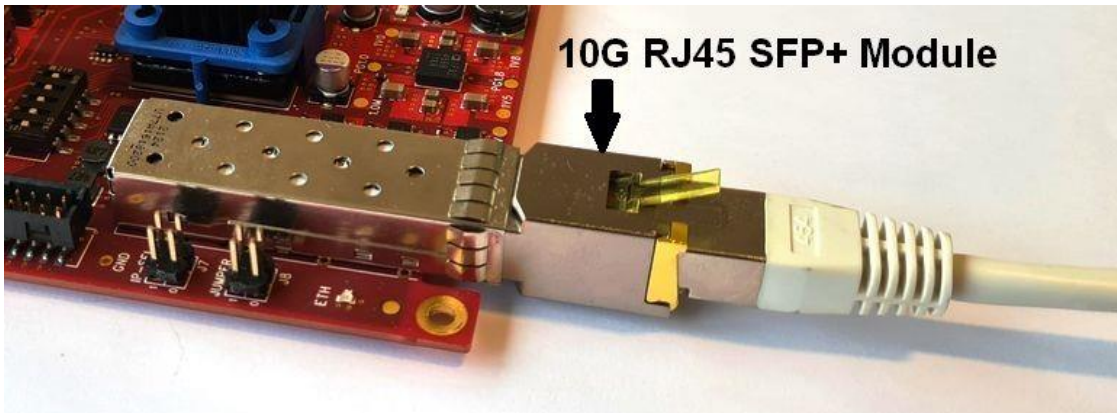


IMAGE 6 - 10-GIGABIT ETHERNET WITH CAT6/7 CABLE

#### 4.1.3 1-Gigabit Ethernet with CAT5/6 Cable

In this configuration, a 1G capable SFP Ethernet RJ45 module is attached to the SFP3 connector. RJ45 module can be connected to a 1G capable host through CAT5 or CAT6 cable.

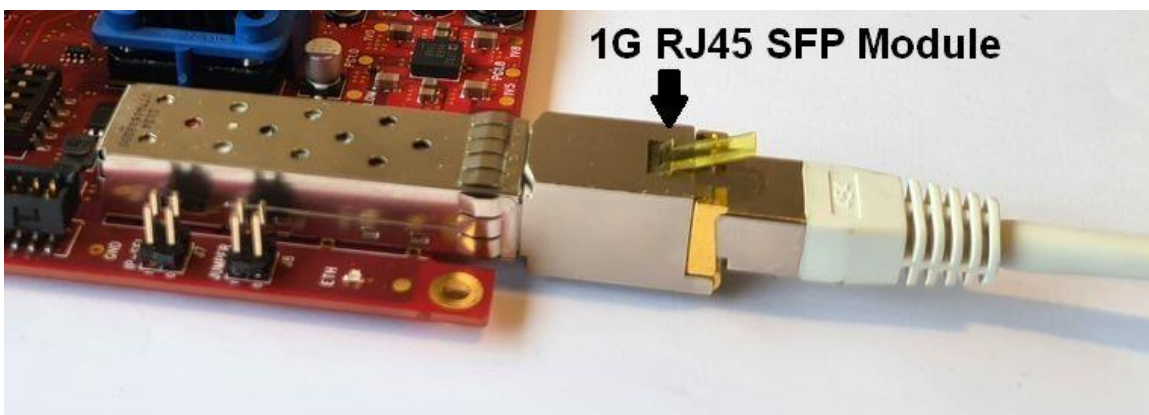


IMAGE 7 - 1-GIGABIT ETHERNET WITH CAT5/6 CABLE

## 4.2 Optical Interface for Printhead Boards (SFP1, SFP2)

APMB4-10G connects to printhead boards over optical fiber cable. Fiber cable is connected to an SFP (small form factor pluggable) transceiver module and plugged into the SFP connector. There are 2 SFP connectors on board each with 4 ports. Total 8 SFP modules can be connected.

Following image shows SFP Module attachment. Bottom modules are attached 180° rotated.



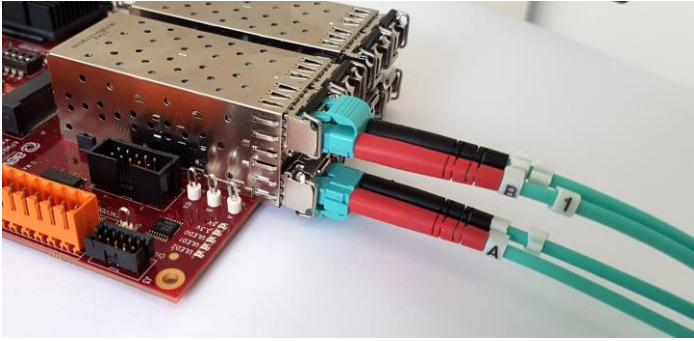


IMAGE 8 - OPTICAL FIBER CONNECTION WITH SFP MODULES

Following image shows the SFP module to printhead board mapping. Printhead boards are numbered starting from 0.

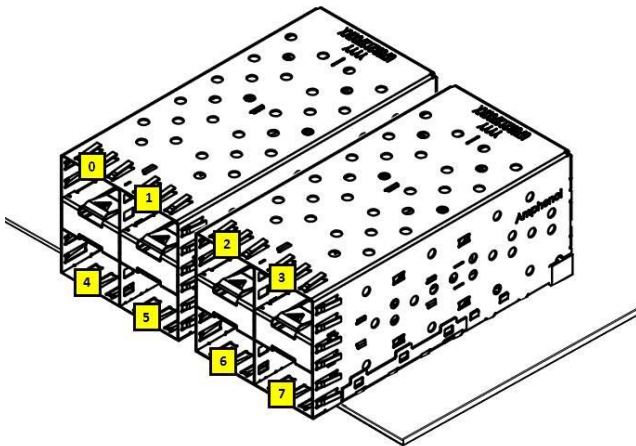


IMAGE 9 – SFP TO PRINthead BOARD MAPPING

APMB4-10G is delivered with SFP transceiver modules, but the optical cable is not included since the distance from the APMB4-10G to head boards differs from system to system.

Following table shows the fiber cables supported.

Fiber Cable Type	Distance between APMB4 and Printhead boards
<b>OM2, 62.5µm/125µm, Multimode fiber, with LC connectors</b>	0.5-300m
<b>OM3, 50µm/125µm, Multimode fiber, with LC connectors</b>	0.5-500m

TABLE 2 - SUPPORTED OPTICAL FIBER CABLES



### 4.3 Power Input Connector (SK1)

SK1 is a 2-port terminal block connector for power input. Switching mode or analog AC/DC power converters can be used. Converters with PFC feature is recommended.

See also Electrical and Thermal Characteristics section.

### 4.4 Encoder Input (SK5)

APMB4-10G has an 8 pin encoder input (SK15) with A, B and Index signals. It can deliver 5V power to the encoder up to 0.5A current.

Inputs are RS422/485 compatible. If connected to a 3.3V or 5V TTL logic directly, resistors R3, R4 and R5 must be unsoldered.

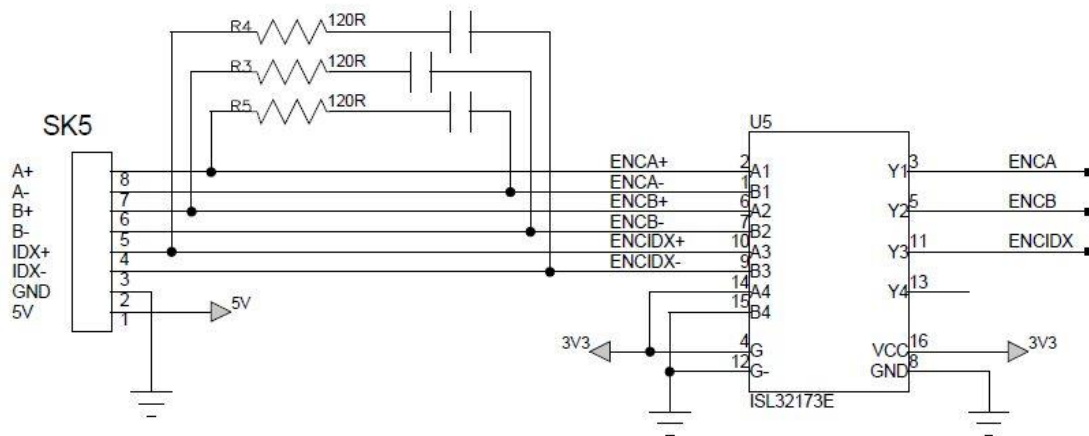


IMAGE 10 – ENCODER



## 4.5 Optically Isolated Inputs (SK2)

Following image is the simplified schematics of the optically isolated inputs. Software reads an active input as 0 and an inactive input as 1.

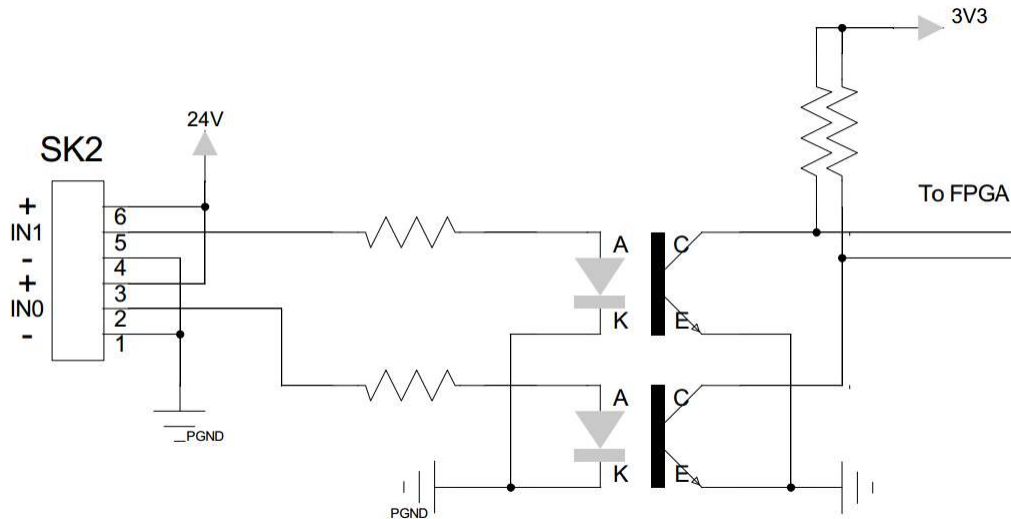


IMAGE 11 - ISOLATED INPUTS

Following table summarizes the functions of isolated inputs.

Input Number	Function
IN0	Start print input if single pass band or continuous mode is activated, otherwise general purpose input. A 3-Wire PNP or NPN sensor or photocell can be connected to this input. See following image for the connection diagram.
IN1	NULL input if rotary printing mode is selected, otherwise general purpose input.

TABLE 3 - INPUT FUNCTIONS



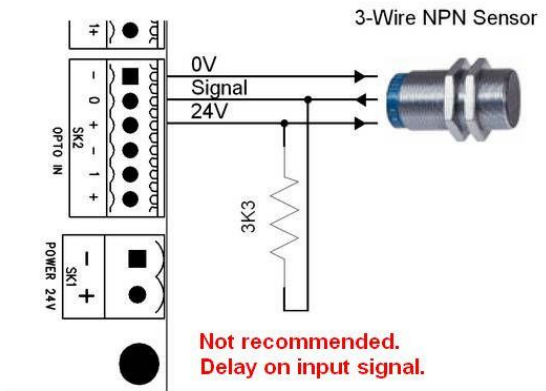
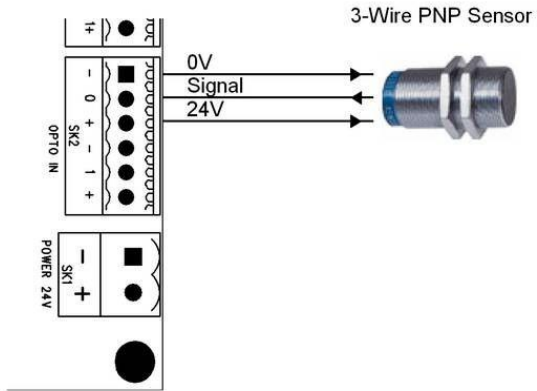


IMAGE 12 – PNP AND NPN SENSOR CONNECTION



## 4.6 Optically Isolated Outputs (SK3)

Following image is the simplified schematics of the optically isolated outputs. Each output can withstand up to 50mA current. They are normally open NPN contacts and can be activated by writing 1 to the corresponding bit through APMB software library.

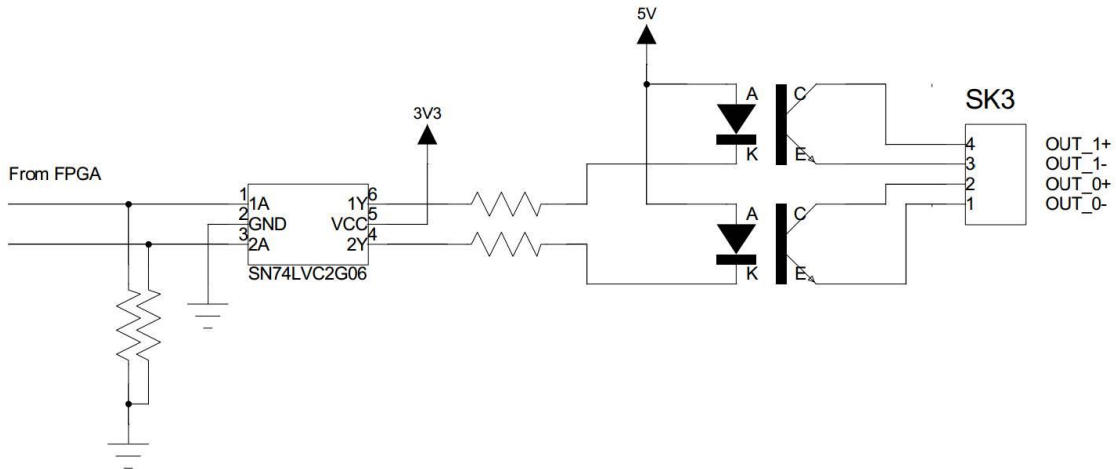


IMAGE 13 - OPTICALLY ISOLATED OUTPUTS

Following table summarizes the functions of isolated outputs.

Output Number	Function
OUT_0	Curing lamp on/off signal if single pass or continuous mode is selected, otherwise general purpose output.
OUT_1	Second Curing lamp on/off signal if single pass or continuous mode is selected, otherwise general purpose output.

TABLE 4 - OUTPUT FUNCTIONS

## 4.7 Dropwatcher trigger output (SK4)

SK4 gives a 5V TTL signal which is synchronous to the pixel clock. Its width is software programmable. It can be connected directly to a dropwatcher trigger input.

Following image is the simplified schematics of the SK4.



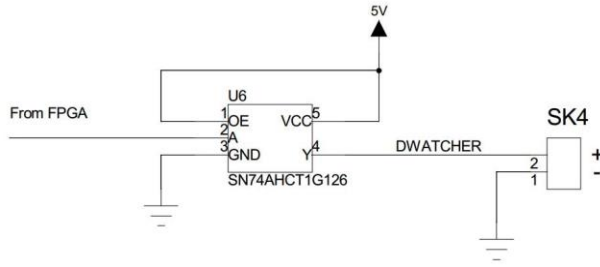


IMAGE 14 – DROPWATCHER OUTPUT

## 4.8 Daisy chain input (J2)

Used only if more than one APMB4-10G boards are connected to the printing system. Connect this input to the daisy chain output connector (J3) of the previous board in the chain.

See also next section.

## 4.9 Daisy chain output (J3)

Used only if more than one APMB4 boards are connected to the printing system. Connect this output to the daisy chain input connector (J2) of the next board in the chain.

Following image shows the typical connection of APMB4-10G boards in a daisy chain.

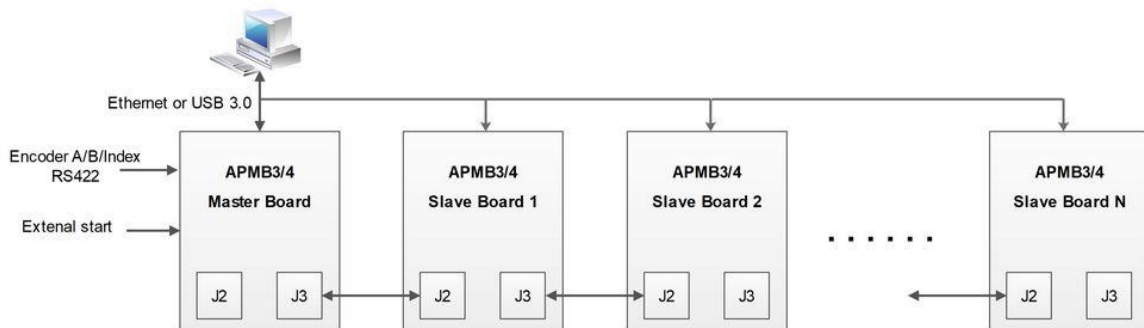


IMAGE 15 – APMB4-10G DAISY CHAINING

## 4.10 Extension connector (J4)

10 pin extension connector (8 signals) with 3.3V LVTTTL inputs and outputs.

Currently this extension connector has no dedicated inputs or outputs. It is programmed if customer has special input or output requirements.





## 4.11 I/O Extension connector (J5)

Reserved for future use.

## 4.12 IP-Address Switch (SW1)

APMB4-10 FPGA board has a 5-port switch on board which selects the fourth byte of the board's IP address. Third byte is selected by a 2-port Jumper (J7) on the APMB4-10G board.

Switch positions generate a hexadecimal number as in the following table.

SW5 Position	SW4 Position	SW3 Position	SW2 Position	SW1 Position	IP Address Select for Ethernet
OFF	OFF	OFF	OFF	OFF	192.168.xxx.50
OFF	OFF	OFF	OFF	ON	192.168.xxx.51
OFF	OFF	OFF	ON	OFF	192.168.xxx.52
OFF	OFF	OFF	ON	ON	192.168.xxx.53
OFF	OFF	ON	OFF	OFF	192.168.xxx.54
OFF	OFF	ON	OFF	ON	192.168.xxx.55
OFF	OFF	ON	ON	OFF	192.168.xxx.56
OFF	OFF	ON	ON	ON	192.168.xxx.57
OFF	ON	OFF	OFF	OFF	192.168.xxx.58
OFF	ON	OFF	OFF	ON	192.168.xxx.59
OFF	ON	OFF	ON	OFF	192.168.xxx.60
OFF	ON	OFF	ON	ON	192.168.xxx.61
OFF	ON	ON	OFF	OFF	192.168.xxx.62
OFF	ON	ON	OFF	ON	192.168.xxx.63
OFF	ON	ON	ON	OFF	192.168.xxx.64
OFF	ON	ON	ON	ON	192.168.xxx.65
ON	OFF	OFF	OFF	OFF	192.168.xxx.66
ON	OFF	OFF	OFF	ON	192.168.xxx.67
ON	OFF	OFF	ON	OFF	192.168.xxx.68
ON	OFF	OFF	ON	ON	192.168.xxx.69
ON	OFF	ON	OFF	OFF	192.168.xxx.70
ON	OFF	ON	OFF	ON	192.168.xxx.71



ON	OFF	ON	ON	OFF	192.168.xxx.72
ON	OFF	ON	ON	ON	192.168.xxx.73
ON	ON	OFF	OFF	OFF	192.168.xxx.74
ON	ON	OFF	OFF	ON	192.168.xxx.75
ON	ON	OFF	ON	OFF	192.168.xxx.76
ON	ON	OFF	ON	ON	192.168.xxx.77
ON	ON	ON	OFF	OFF	192.168.xxx.78
ON	ON	ON	OFF	ON	192.168.xxx.79
ON	ON	ON	ON	OFF	192.168.xxx.80
ON	ON	ON	ON	ON	192.168.xxx.81

TABLE 5 – IP-ADDRESS SWITCH FUNCTION TABLE

### 4.13 IP-SEL Jumper (J7)

APMB4-10G has a 2-port jumper which selects the third byte of the board's IP address. Fourth byte is selected by a 5-port switch SW1.

Jumper 1	Jumper 0	IP Address Select for Ethernet
Open	Open	192.168.060.xxx
Open	Closed	192.168.100.xxx
Closed	Open	192.168.140.xxx
Closed	Closed	Use IP Address set by software.

TABLE 6 – JUMPER FUNCTION TABLE

If both jumpers are closed, IP-Address is read from a user programmable EEPROM. Final IP address is generated using ID-Switch positions.

For example, if the IP-Address in the EEPROM is 192.168.20.20, final IP-Address with respect to IP-Address Switch positions will be like in the following table.

SW5 Position	SW4 Position	SW3 Position	SW2 Position	SW1 Position	Final IP Address
OFF	OFF	OFF	OFF	OFF	192.168.20.20
OFF	OFF	OFF	OFF	ON	192.168.20.21
OFF	OFF	OFF	ON	OFF	192.168.20.22
OFF	OFF	OFF	ON	ON	192.168.20.23



OFF	OFF	ON	OFF	OFF	192.168.20.24
OFF	OFF	ON	OFF	ON	192.168.20.25
OFF	OFF	ON	ON	OFF	192.168.20.26
OFF	OFF	ON	ON	ON	192.168.20.27
OFF	ON	OFF	OFF	OFF	192.168.20.28
OFF	ON	OFF	OFF	ON	192.168.20.29
OFF	ON	OFF	ON	OFF	192.168.20.30
OFF	ON	OFF	ON	ON	192.168.20.31
OFF	ON	ON	OFF	OFF	192.168.20.32
OFF	ON	ON	OFF	ON	192.168.20.33
OFF	ON	ON	ON	OFF	192.168.20.34
OFF	ON	ON	ON	ON	192.168.20.35
ON	OFF	OFF	OFF	OFF	192.168.20.36
....	....	....	....	....	....
ON	ON	ON	OFF	OFF	192.168.20.48
ON	ON	ON	OFF	ON	192.168.20.49
ON	ON	ON	ON	OFF	192.168.20.50
ON	ON	ON	ON	ON	192.168.20.51

TABLE 7 - IP-ADDRESS SWITCH FUNCTION TABLE

## 4.14 Jumper (J8)

Reserved for future use.

## 4.15 APMB4-10G LEDs

There are 5 diagnostics LEDs on the APMB4-10G PCB.

**PG:** Power good indicator LED.

**3V3:** Connected to the 3.3V power rail.

**DONE:** This LED is ON when the FPGA firmware is loaded correctly.

**ETH:** Ethernet status LED. Available only on REV B or newer boards. Placed closed to SFP3. ETH LED can be in 3 different states:

- OFF: Ethernet line is idle. No connection to the host.



- Blinking, 1 seconds: Connected to the host.
- ON: Connected to the host. Host software is also connected through TCP/IP sockets.

**TEST:** Test LED. Following table shows errors reported by the Test LED.

USR2 LED Behavior	Meaning
Off	No error.
Blink once, than OFF for 1 second	TX Error. Data rate is too high or encoder signal is too fast.
Blink 2 times, than OFF for 1 second	Locked error. Motion control block could not be locked when multiplying or dividing the encoder input.
Blink 3 times, than OFF for 1 second	Pixel count error. Motion control block could not generate the requested number of pixel clocks.
Blink 4 times, than OFF for 1 second	Pixel delay error. At least one of the pixel delays set by the software is too high.
Blink 5 times, than OFF for 1 second	No meaning. Reserved for future use.
Blink 6 times, than OFF for 1 second	No meaning. Reserved for future use.
Blink 7 times, than OFF for 1 second	RAM memory error.

TABLE 8 - USR2 LED FUNCTIONS

Same errors can also be read by software. More error types might be added in future with firmware updates.

## 4.16 Test Header (J6)

J6 is the test header for internal use by AEWA.

## 4.17 JTAG Connector (J1)

This connector is for internal use by AEWA for testing, debugging and updating the firmware. APMB4-10G firmware can also be updated over optical interface using ApmbDiag or APRINT software.

## 4.18 Test Points

Following table is a list of the test points which are accessible by user.

TP Ref. des.	Function



TP4	Digital logic ground
TP1	Encoder A signal
TP2	Encoder B signal
TP3	Encoder Index signal

TABLE 9 - TEST POINTS

There are some other test points on APMB4-10G PCB which are not listed in the table above. They are for internal use only.

## 5 Electrical and Thermal Characteristics

Parameter	Value
<b>Input Voltage</b>	24V (10 - 28V)
<b>Max. current consumption, with 1G SFP RJ45 Module, without any external components</b>	290 mA @24V
<b>Max. current consumption, 10G SFP+ optical module, without any external components</b>	250 mA @24V
<b>Max. current consumption for each printhead board SFP connected</b>	36mA @24V
<b>Max. current consumption for each active isolated input</b>	6.6 mA @24V
<b>Max. current consumption for each active isolated output (contact current is not included)</b>	1.8 mA @24V
<b>Max. current on encoder power output</b>	0-500 mA @5V 0-120 mA @24V
<b>Operating free-air temperature</b> (Use a fan above this temperature)	0-45°C

TABLE 10 -ELECTRICAL AND THERMAL CHARACTERISTICS



# 6 Mechanical Dimensions

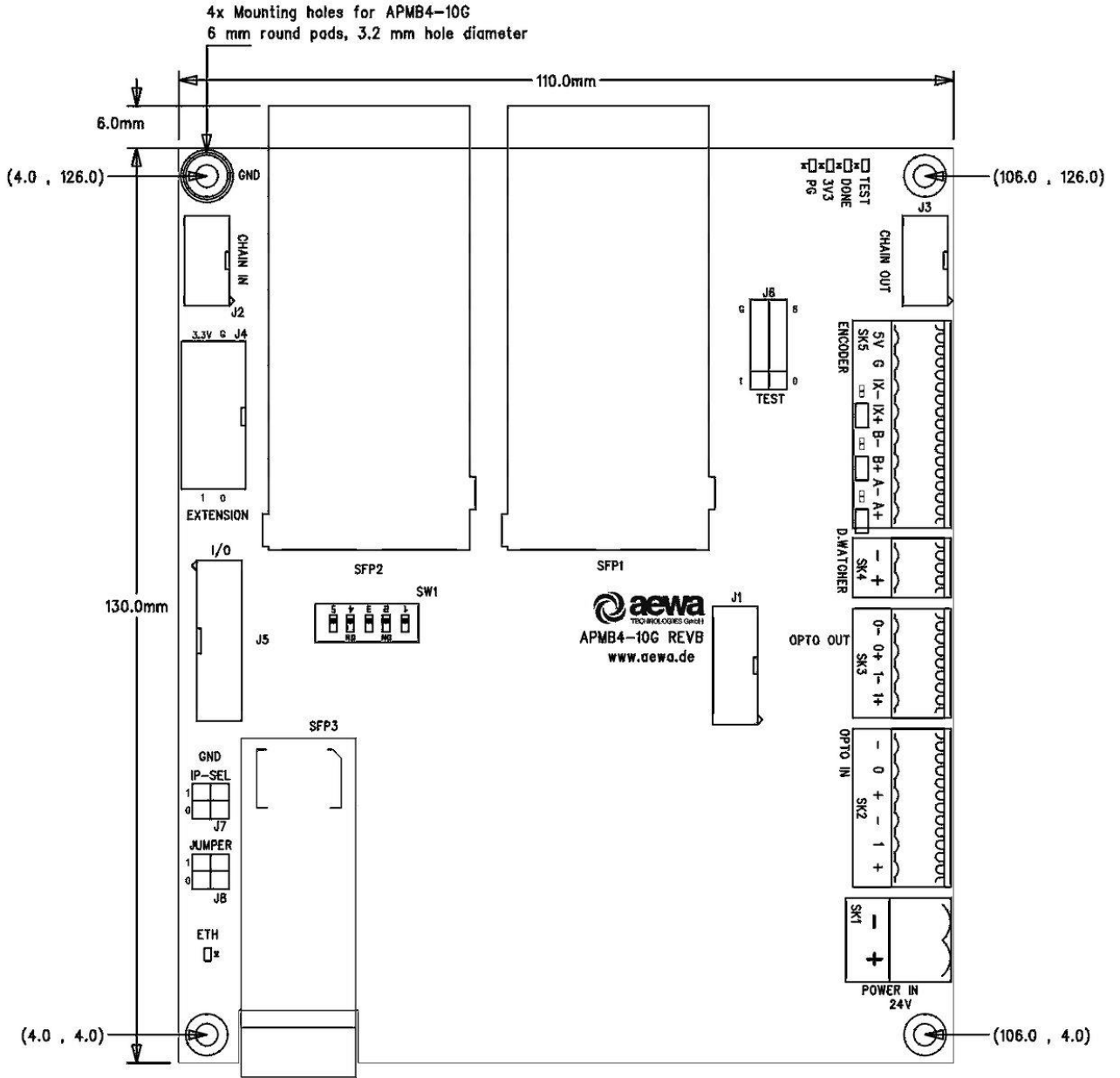


IMAGE 16 – APMB4-10G MECHANICAL DIMENSIONS



## 7 Connectors and Cables

APMB4-10G is assembled with very high quality industrial terminal blocks and connectors for power in and input/output. Following table lists the PCB connectors and their mating cable connectors. Notice that mating connectors are just examples. Please see the manufacturer datasheets for other types.

Description	PCB Side	Mating side
SK1 - Power input connector	Phoenix Contact, 5.08 mm raster MSTBVA 2,5/ 2-G-5,08 Order No: 1755736	Phoenix Contact, 5.08 mm raster MSTB 2,5/ 2-ST-5,08 Order No: 1757019
SK4 - Dropwatcher output	Weidmüller, 3.5mm raster, 2 pins SL 3.50/02/180G Order No: 1604470000	Weidmüller, 3.5mm raster, 2 pins BL 3.50/02/180 SN or BX Order No: 1597360000
SK3 - Isolated outputs	Weidmüller, 3.5mm raster, 4 pins SL 3.50/04/180G Order No: 1604490000	Weidmüller, 3.5mm raster, 4 pins BL 3.50/04/180 SN or BX Order No: 1597380000
SK2 - Isolated inputs	Weidmüller, 3.5mm raster, 6 pins SL 3.50/06/180G Order No: 1604510000	Weidmüller, 3.5mm raster, 6 pins BL 3.50/06/180 SN or BX Order No: 1597400000
SK5 - Encoder connector	Weidmüller, 3.5mm raster, 8 pins SL 3.50/08/180G Order No: 1605130000	Weidmüller, 3.5mm raster, 8 pins BL 3.50/08/180 SN or BX Order No: 1597420000
J2,J3 - Daisy chain input/output connectors	Molex 10-pin PCB Header, closed, 2mm raster Order No: 0878311042	Molex 10-pin cable connector, 2mm raster Order No: 0875681074
Cable for J2 and J3		3M Flat ribbon cable, 10 conductors, 1.0mm raster, maximum 30cm Order No: 82-28-3010 or equivalent
J4 – Extension connector	Multicomp 10-pin PCB Header, closed, 2.54mm raster Order No: MC9A12-1034	Multicomp 10-pin cable connector, 2.54mm raster Order No: MC-254-10-00-00-IDC





Cable for J4		3M Flat ribbon cable, 10 conductors, 1.27mm raster, maximum 30cm Order No: 3365/10 or equivalent
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TABLE 11 – CONNECTORS AND CABLES



## 8 Ordering Information

APMB4-10G can be ordered with the ordering numbers:

**APMB4-10G** : for 10G Ethernet, includes 10G SFP+ fiber optic module.

**APMB4-10G-1G** : for 1G Ethernet, includes 1G SFP RJ45 module.

