



AMPB2
AEWA PRINT MANAGER BOARD
HARDWARE USER GUIDE

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Version 1.7

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1 Overview

APMB2 is the second 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

APMB2 is currently capable of connecting to the host PC via 1-Gigabit Ethernet and USB 3.0. 10-Gigabit Ethernet interface is under development.

Performance

1-Gigabit Ethernet: 110 Mbytes/sec, uses TCP/IP offloading. 2Gb RAM.

USB3.0: 400 Mbytes/sec. 4Gb or 8Gb RAM.

10-Gigabit Ethernet : >500 Mbytes/sec, uses TCP/IP offloading

Optical interface to print heads: 600 Mbits/sec

Encoder: 80 Mbits/sec

RS422: 10 Mbits/sec

Digital to analog converter: Precision 12-Bits, 6 μ s settling time

Printing Modes

Many printing modes are implemented in standard APMB2 firmware including rotary spiral, rotary step, flatbed, 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.



APMB2 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.

Printhead Control

APMB2 enables to access all printhead settings including temperature set-point, current temperature, voltage control, fire waveform control and grey scale adjustment.

Firmware Update

APMB2 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 inputs, outputs and relays are available on 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 galvanic isolation, over voltage protection, over current protection, reverse polarity protection, surge current protection and transient overvoltage protection.

Security

All APMB2 FPGA Boards are equipped with a SHA-1 Encryption EEPROM for firmware copy protection.



2 Block Diagrams

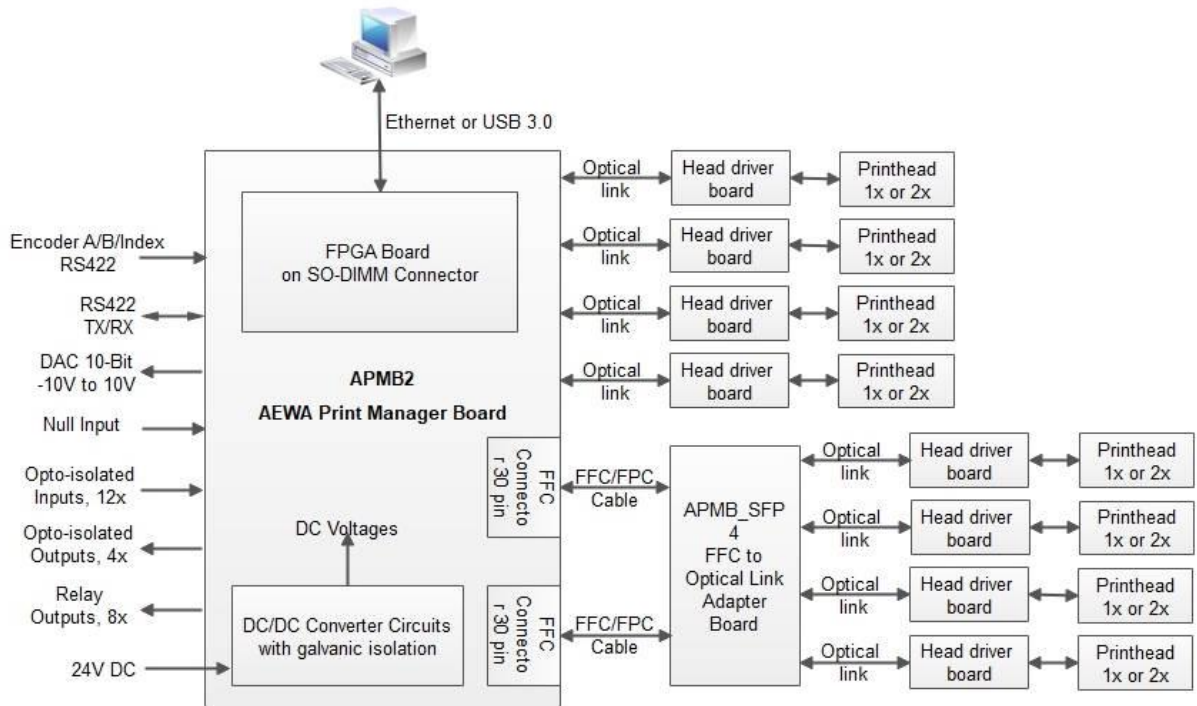


IMAGE 1 - APMB2 HARDWARE BLOCK DIAGRAM

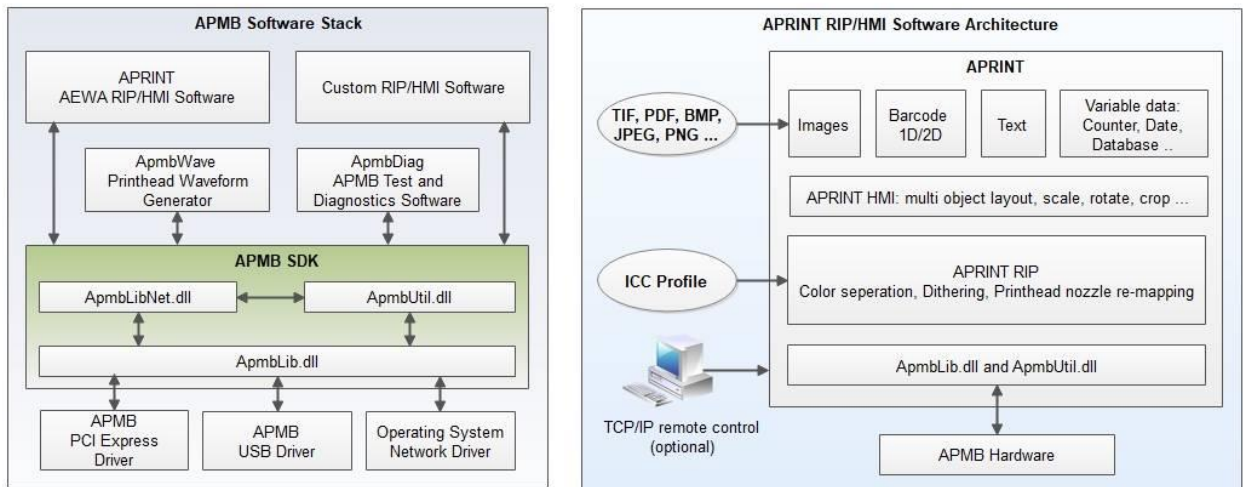


IMAGE 2 - APMB SOFTWARE BLOCK DIAGRAM

3 External Connections

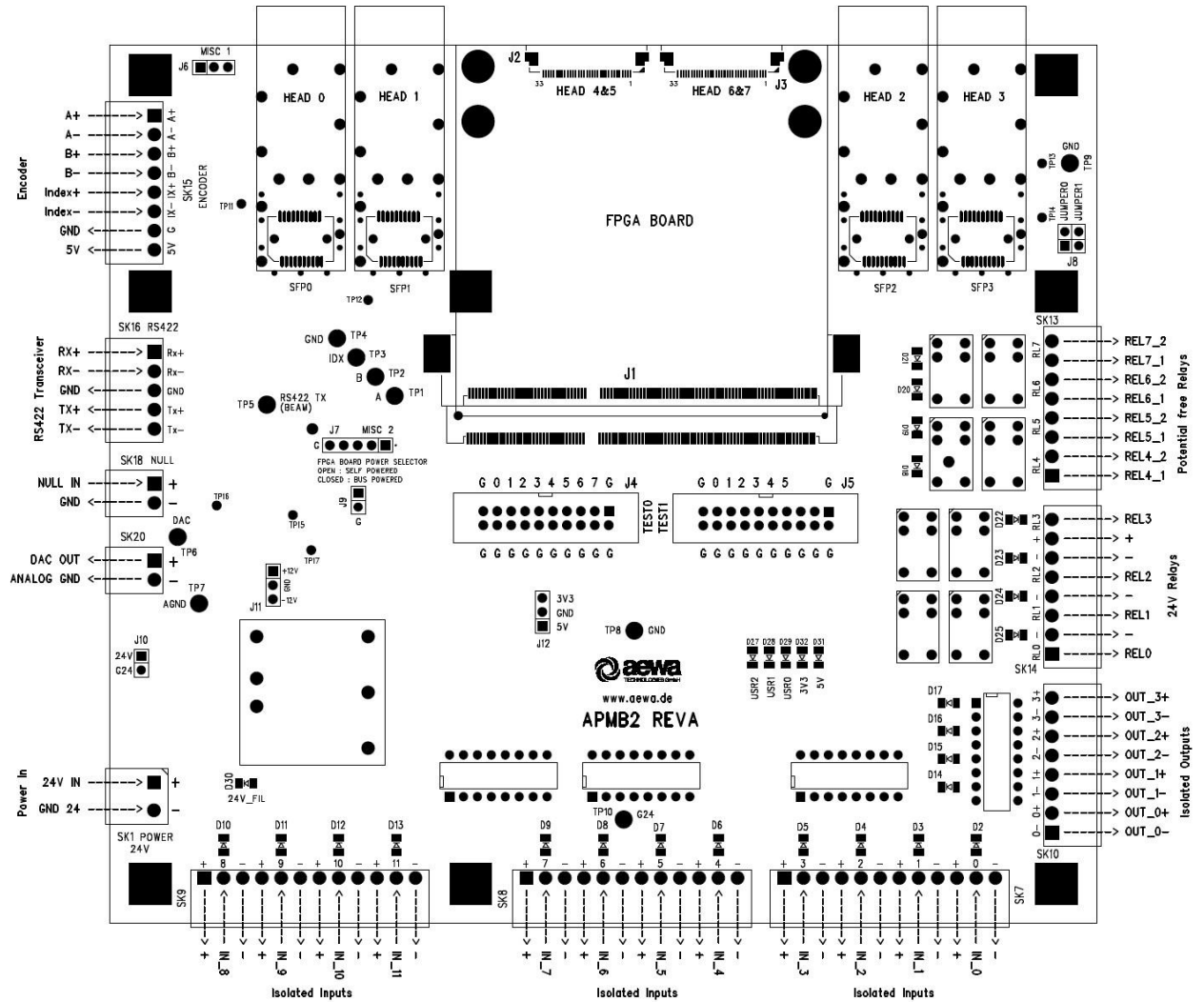


IMAGE 3 - APMB2 EXTERNAL CONNECTIONS



4 Board Components

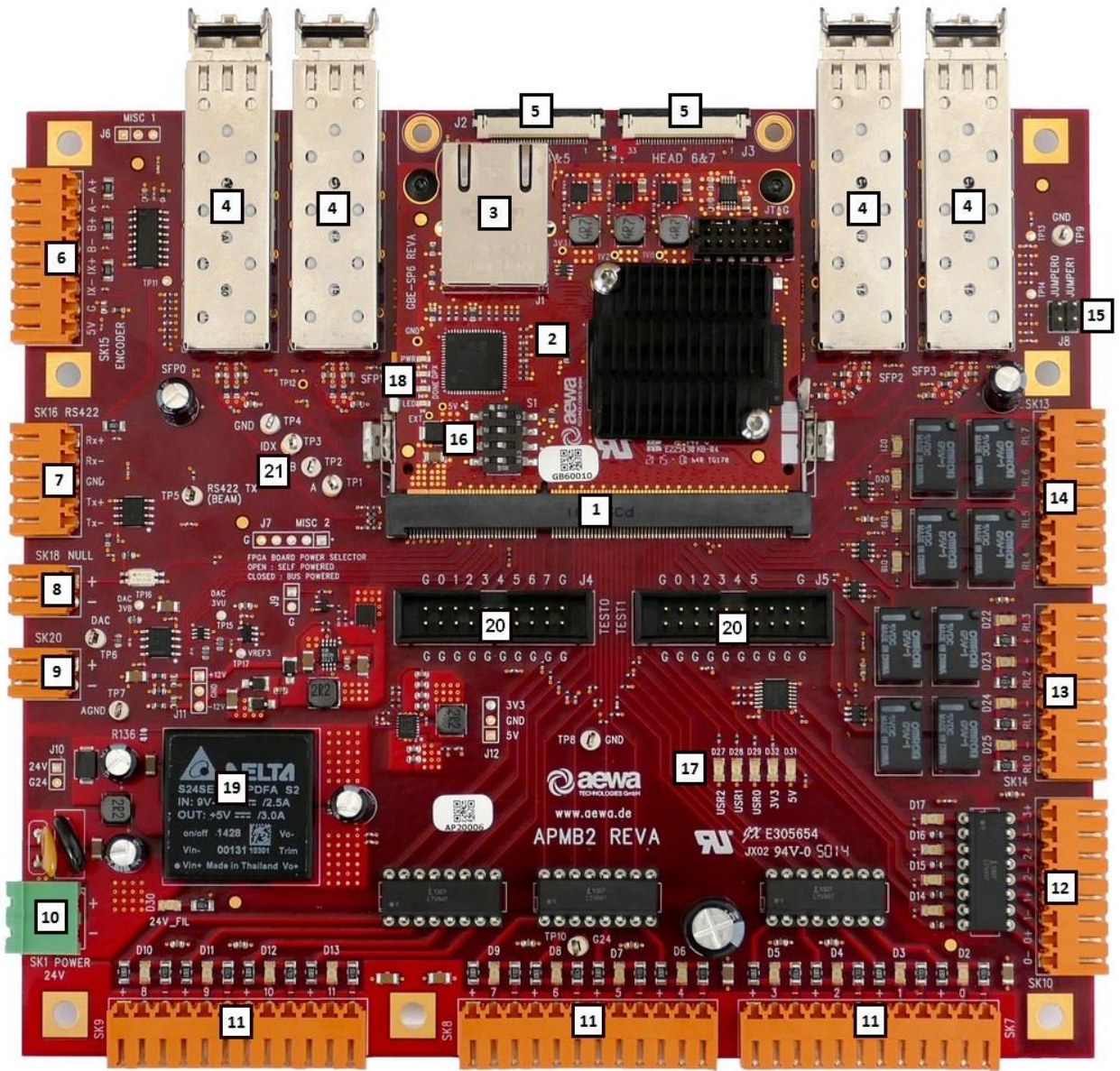


IMAGE 4 - APMB2 BOARD COMPONENTS

4.1 FPGA Board Connector (J1)

Unlike print manager boards from other vendors, APMB2 doesn't have on board FPGA, RAM or host interface. Instead, these features are on plug-in FPGA boards which are attached to the APMB2 through a 204 pin SO-DIMM edge connector J1.

4.2 FPGA Board

AEWA develops different FPGA boards which are compatible to APMB2. Although they have different FPGAs, host interfaces and memories, they can be controlled with APMB software library with same functions.

Below is a list of currently available FPGA boards:

FPGA Board Name	Description	APMB2 Type
GBE-SP6	APMB2 FPGA board with 1-Gigabit Ethernet and 2Gb RAM	APMB2-GBE
USB3-SP6	APMB2 FPGA board with USB3 and 4Gb/8Gb RAM	APMB2-USB
KX-10GBE	APMB2 FPGA board with 10-Gigabit Ethernet and SO-DIMM DDR3 SDRAM Connector (under development)	APMB2-10G

TABLE 1 - APMB2 FPGA BOARDS

4.3 Host Connector

Following cables are supported on host connector:

FPGA Board Name	Cable Type, Length
GBE-SP6	CAT 5e or Cat 6 cable up to 90m,
USB3-SP6	Standard USB 3 cable, up to 3m. More distance with USB 3 cable repeater.
KX-10GBE	CAT 6 cable up to 50m, CAT 6a cable up to 90m.

TABLE 2 - APMB2 HOST INTERFACE CABLES

4.4 Optical Interface for Printhead Boards (SFP0 ... SFP3)

APMB2 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 4 SFP connectors on board. 4 more SFP connections can be added by connecting FFC to SFP connector board (See next section) to APMB2.



APMB2 is delivered with SFP transceiver modules, but the optical cable is not included since the distance from the APMB2 to head boards differs from system to system.

Following table shows the fiber cables supported.

Fiber Cable Type	Distance between APMB2 and Printhead boards
OM2, 62.5µm/125µm, Multimode fiber, with LC connectors	0.5-300m
OM3, 50µm/125µm, Multimode fiber, with LC connectors	0.5-500m

TABLE 3 - SUPPORTED OPTICAL FIBER CABLES



IMAGE 5 - OPTICAL FIBER CONNECTION WITH SFP MODULE

4.5 Optical Interface Extension Connectors (J2 and J3)

APMB2 supports 4 printhead connections since it has 4 SFP optical interfaces on board. 4 more printhead boards can be connected through FFC to SFP connector board which is called APMB_SFPx4. FFC cables are delivered with APMB_SFPx4 board.

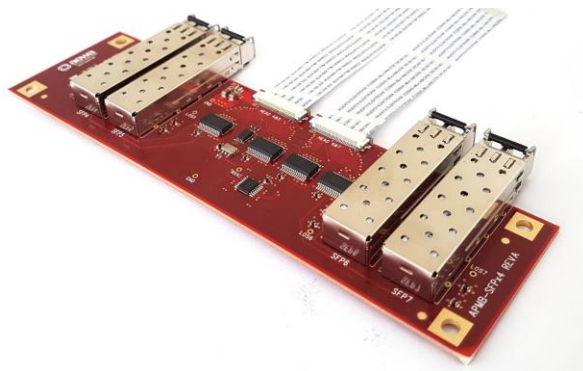


IMAGE 6 – APMB2-SFPx4 BOARD



4.6 Encoder Input (SK15)

APMB2 has an 8 pin encoder input (SK15) with A, B and Index signals. It can deliver 5V power to the encoder up to 1A current. Inputs are RS422/485 compatible.

4.7 RS422 Transceiver (SK16)

APMB2 has a full duplex RS422 transceiver which supports data speeds up to 10 Mbaud. On rotary spiral systems the receiver side is idle and the transmitter is the beam signal. Beam signal gives encoder pulses out for seamless movement of the drum whenever firmware is printing. For other systems RS422 transceiver can be used as a general purpose bidirectional data port with user configurable baud rate and data width. It can also be used to control ink supply systems with RS422 interface.

4.8 Null Input (SK18)

On some rotary machines cylinders are printed more than one times. After first print the cylinder is removed and put back after a chemical process. The index point is lost because of the removal. The operator must turn the cylinder, observe the position of an index marker with a camera and close a switch once which is connected to the NULL input. The firmware automatically shifts the encoder index to the currently defined point.

4.9 Digital to Analog Converter (SK20)

APMB2 has a precision DAC with buffered output. It can be controlled with APMB software library.

Following table summarizes the DAC features:

Output Voltage (V)	-10 to 10 Volts
Max. Output Current	±10 mA
Accuracy	1 LSB INL
Resolution	12 bits
Settling time	6µs typical, 10µs max.

TABLE 4 - DIGITAL TO ANALOG CONVERTER FEATURES



4.10 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.



4.11 Optically Isolated Inputs (SK7, SK8, SK9)

Following image is the simplified schematics of the optically isolated inputs. Notice that the input numbering of SK9 is opposite of SK7 and SK8. Software reads an active input as 0 and an inactive input as 1.

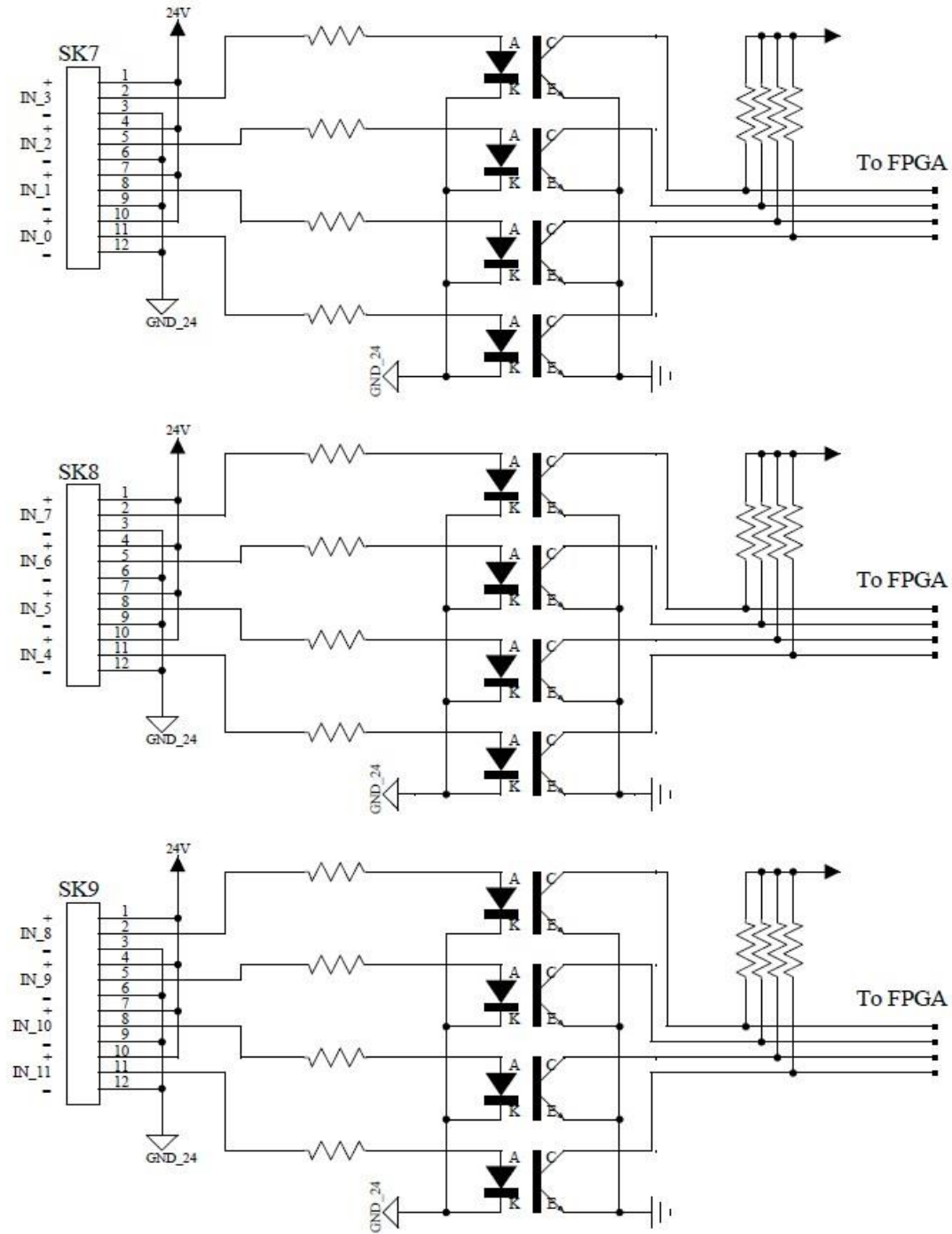


IMAGE 7 - ISOLATED INPUTS



Following table summarizes the functions of isolated inputs.

Input Number	Function
IN_0	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.
IN_1	General purpose input.
IN_2	General purpose input.
IN_3	General purpose input.
IN_4	Motor stop switch 1 if stepper motor controller is activated otherwise general purpose input.
IN_5	Motor stop switch 2 if stepper motor controller is activated otherwise general purpose input
IN_6	General purpose input.
IN_7	General purpose input.
IN_8	General purpose input.
IN_9	General purpose input.
IN_10	General purpose input.
IN_11	General purpose input.

TABLE 5 - INPUT FUNCTIONS

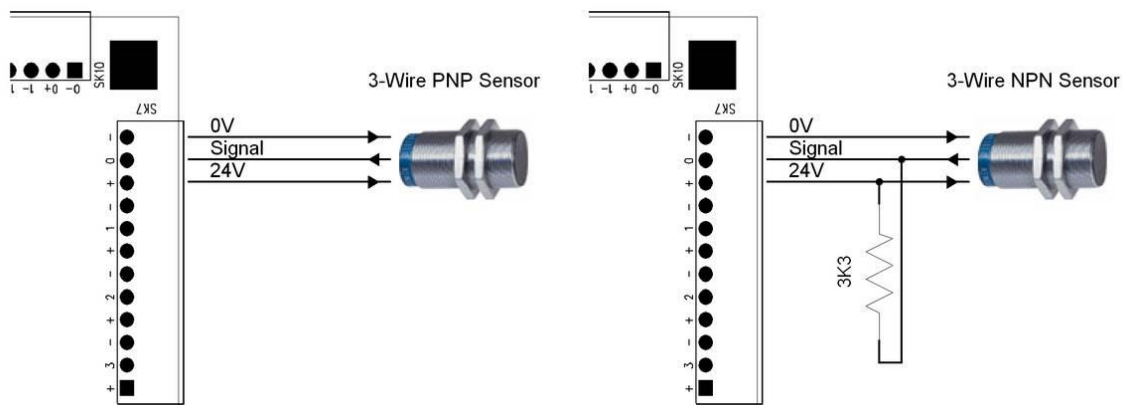


IMAGE 8 – PNP AND NPN SENSOR CONNECTION



4.12 Optically Isolated Outputs (SK10)

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.

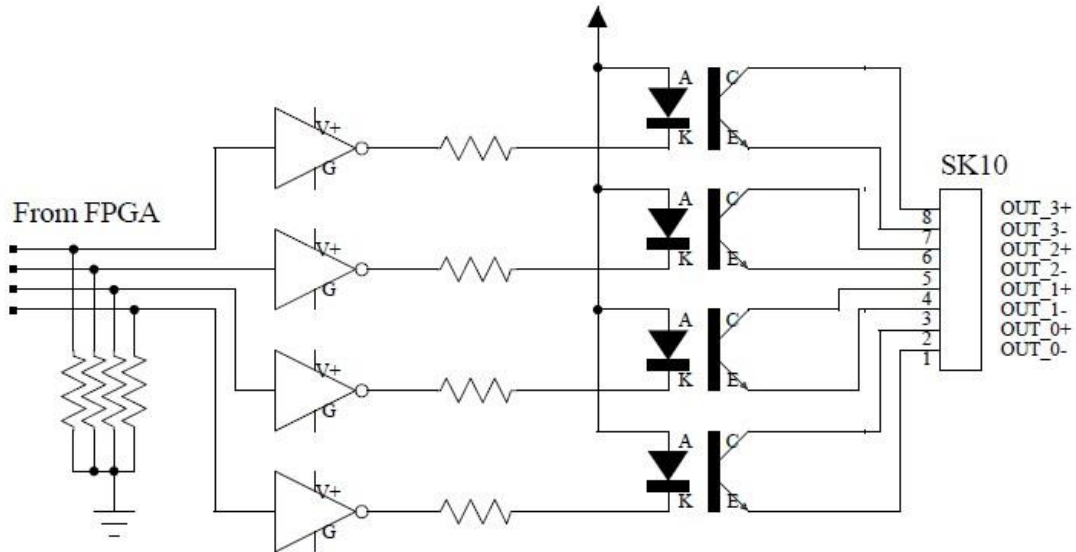


IMAGE 9 - OPTICALLY ISOLATED OUTPUTS

Following table summarizes the functions of isolated outputs.

Output Number	Function
OUT_0	General purpose output.
OUT_1	Curing lamp on off signal if single pass or continuous mode is selected, otherwise general purpose output.
OUT_2	Motor DIR signal if stepper motor controller is activated, otherwise general purpose output.
OUT_3	Motor CLK signal if stepper motor controller is activated, otherwise general purpose output.

TABLE 6 - OUTPUT FUNCTIONS



4.13 24V Relays

Following image is the simplified schematics of the 24V Relays. Each relay can carry up to 1A of current. Notice that the third relay (REL3) has slightly different connection than others. They are normally open contacts and can be activated by writing 1 to the corresponding bit through APMB software library. By default, none of them have dedicated functions.

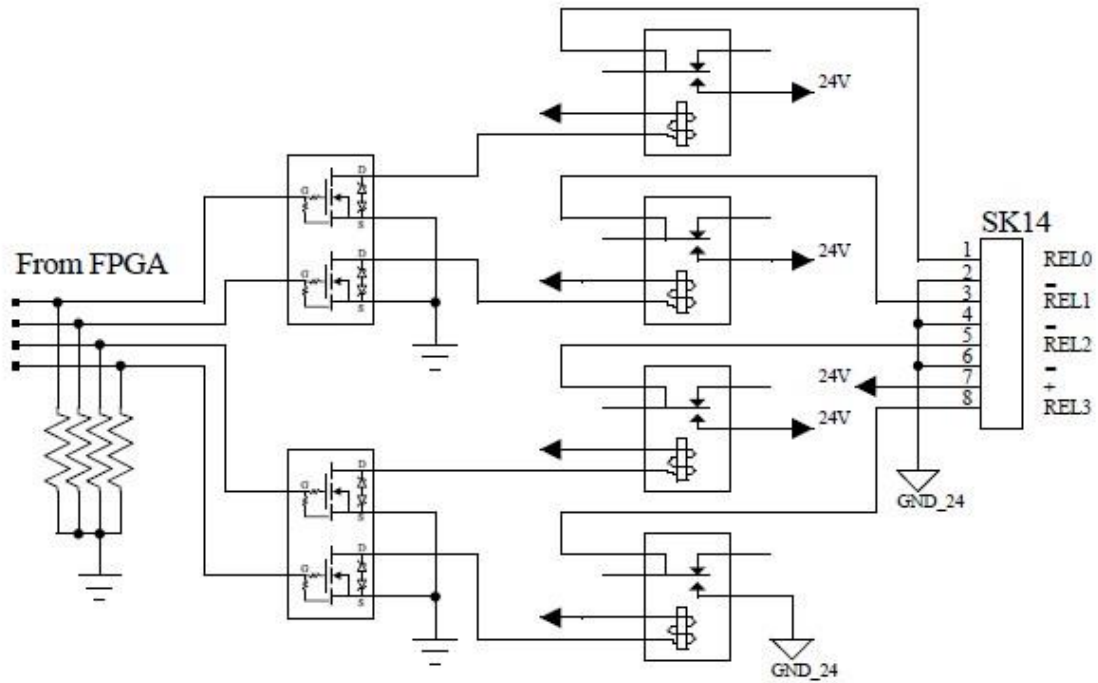


IMAGE 10 - 24V RELAYS

4.14 Potential Free Relays

Following image is the simplified schematics of the four potential free relays. Each relay can carry up to 1A of current. They are normally open contacts and can be activated by writing 1 to the corresponding bit through APMB software library. By default, none of them have dedicated functions.

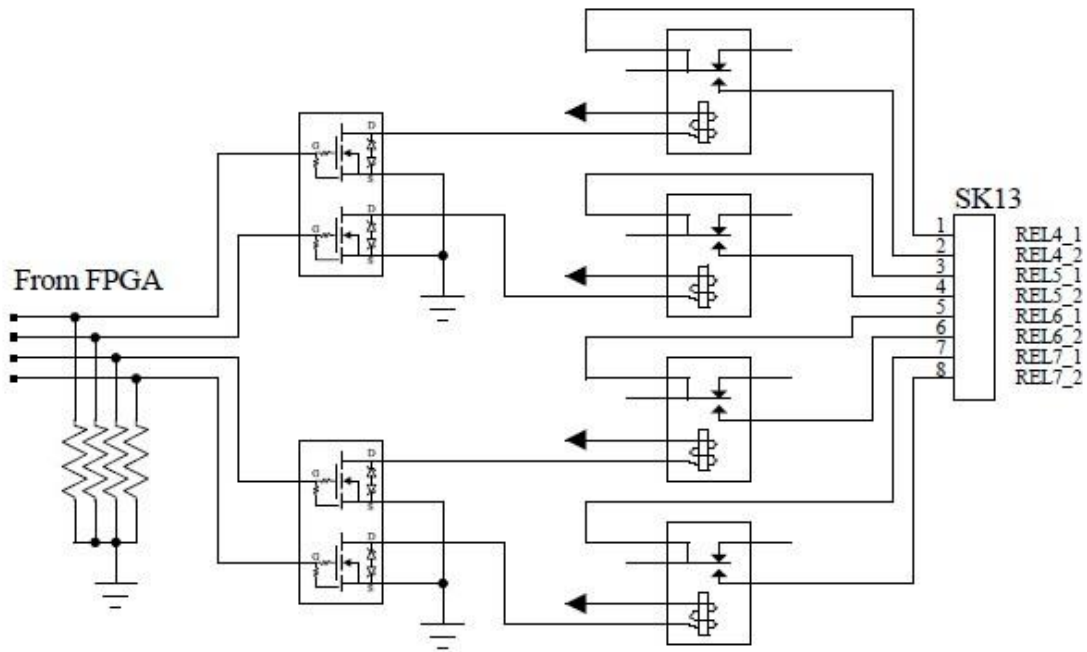


IMAGE 11 - POTENTIAL FREE RELAYS

4.15 ID-Switch

APMB2 FPGA board has a 4-port switch on board. It has different functions for each host interface.

For 1-Gigabit Ethernet and 10-Gigabit Ethernet systems, switch selects the fourth byte of the board's IP address. Third byte is selected by a 2-port Jumper (J8) on the APMB2 board.

On USB system, switch is used to define a device ID in order to distinguish APMB2 boards if more than one is connected to the system. Up to 16 board IDs can be defined.

SW4 Position	SW3 Position	SW2 Position	SW1 Position	IP Address Select for Ethernet	Board ID for USB
OFF	OFF	OFF	OFF	192.168.xxx.50	0
OFF	OFF	OFF	ON	192.168.xxx.51	1
OFF	OFF	ON	OFF	192.168.xxx.52	2
OFF	OFF	ON	ON	192.168.xxx.53	3
OFF	ON	OFF	OFF	192.168.xxx.54	4
OFF	ON	OFF	ON	192.168.xxx.55	5
OFF	ON	ON	OFF	192.168.xxx.56	6
OFF	ON	ON	ON	192.168.xxx.57	7
ON	OFF	OFF	OFF	192.168.xxx.58	8
ON	OFF	OFF	ON	192.168.xxx.59	9
ON	OFF	ON	OFF	192.168.xxx.60	10
ON	OFF	ON	ON	192.168.xxx.61	11
ON	ON	OFF	OFF	192.168.xxx.62	12
ON	ON	OFF	ON	192.168.xxx.63	13
ON	ON	ON	OFF	192.168.xxx.64	14
ON	ON	ON	ON	192.168.xxx.65	15

TABLE 7 – ID-SWITCH FUNCTION TABLE

4.16 Jumper (J8)

APMB2 has a 2-port jumper on board. For 1-Gigabit Ethernet and 10-Gigabit Ethernet systems, jumpers select the third byte of the board's IP address. Fourth byte is selected by a 4-port switch on the FPGA board.



Jumpers have no function for USB system.

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 8 – 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 ID-Switch positions will be like in the following table.

SW4 Position	SW3 Position	SW2 Position	SW1 Position	Final IP Address
OFF	OFF	OFF	OFF	192.168.20.20
OFF	OFF	OFF	ON	192.168.20.21
OFF	OFF	ON	OFF	192.168.20.22
OFF	OFF	ON	ON	192.168.20.23
OFF	ON	OFF	OFF	192.168.20.24
OFF	ON	OFF	ON	192.168.20.25
OFF	ON	ON	OFF	192.168.20.26
OFF	ON	ON	ON	192.168.20.27
ON	OFF	OFF	OFF	192.168.20.28
ON	OFF	OFF	ON	192.168.20.29
ON	OFF	ON	OFF	192.168.20.30
ON	OFF	ON	ON	192.168.20.31
ON	ON	OFF	OFF	192.168.20.32
ON	ON	OFF	ON	192.168.20.33
ON	ON	ON	OFF	192.168.20.34
ON	ON	ON	ON	192.168.20.35

TABLE 9 - ID-SWITCH FUNCTION TABLE



4.17 APMB2 LEDs

There are 3 diagnostics LEDs on the APMB2 PCB which are marked as USR0, USR1 and USR2.

USR0 LED is OFF when SHA-1 Encryption keys programmed into the device is correct. If this LED is ON, complete functions of the APMB2 board are disabled.

USR1 LED is OFF when the image data stream is counting data, otherwise it is ON. This LED is used for internal tests by AEWA.

USR2 is error indicator LED. Following table shows errors reported by USR2 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 10 – USR2 LED FUNCTIONS

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

Following table shows the functions of other LEDs found on APMB2 Board.

LED Ref. des.	Function
D2	ON when isolated input IN_0 is active.
D3	ON when isolated input IN_1 is active.
D4	ON when isolated input IN_2 is active.
D5	ON when isolated input IN_3 is active.
D6	ON when isolated input IN_4 is active.
D7	ON when isolated input IN_5 is active.



D8	ON when isolated input IN_6 is active.
D9	ON when isolated input IN_7 is active.
D10	ON when isolated input IN_8 is active.
D11	ON when isolated input IN_9 is active.
D12	ON when isolated input IN_10 is active.
D13	ON when isolated input IN_11 is active.
D14	ON when isolated output OUT_0 is active.
D15	ON when isolated output OUT_1 is active.
D16	ON when isolated output OUT_2 is active.
D17	ON when isolated output OUT_3 is active.
D25	ON when relay REL0 is active.
D24	ON when relay REL1 is active.
D23	ON when relay REL2 is active.
D22	ON when relay REL3 is active.
D18	ON when relay REL4 is active.
D19	ON when relay REL5 is active.
D20	ON when relay REL6 is active.
D21	ON when relay REL7 is active.
D30	24V LED
D31	5V LED
D32	3.3V LED

TABLE 11 – APMB2 BOARD LEDs

4.18 FPGA Board LEDs

Each FPGA board has different number of LEDs. Following table shows their functions.

LED Name	Function	Notes
PWR	ON when board power is OK.	
DONE	ON when FPGA firmware is loaded correctly.	



DPX	ON when the host PC is connected to the APMB2 and established a duplex Ethernet link.	Only for Ethernet.
LEDF	ON when the host software is connected to the APMB2.	

TABLE 12 – FPGA BOARD LEDs

4.19 DC/DC Converter (U12)

U12 is the DC/DC converter with a minimum 1600 Volts of galvanic isolation. It isolates all DC circuits with the input voltage. All input stages of isolated inputs and output stages of isolated outputs and relays are driven by input voltage (10-28 Volts).

Input stage of the U12 is properly designed to enable over voltage protection, over current protection, reverse polarity protection, surge current protection and transient overvoltage protection.

4.20 Test and Extension Headers (J4, J5)

J4 and J5 are test headers for internal use by AEWA.

4.21 Test Points

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

TP Ref. des.	Function
TP10, J10-Pin2	Input ground
J10-Pin1	Input Voltage, nominal 24 Volts
TP4, TP8, TP9,	Digital logic ground
J11-Pin2, J12-Pin2	Digital logic ground
J12-Pin1	5V
J12-Pin3	3.3V
J11-Pin1	+12V
J11-Pin3	-12V
TP1	Encoder A signal
TP2	Encoder B signal
TP3	Encoder Index signal



TP5	RS422 TX signal, Beam signal for rotary spiral
TP6	Digital to Analog converter output (-10 to 10 Volts)
TP7	Analog ground

TABLE 13 - TEST POINTS

There are some other test points on APMB2 PCB which are not listed in the table above. They are for internal use only.



5 Electrical and Thermal Characteristics

Parameter	Value
Input Voltage	24V (10 - 28V)
Max. current consumption, without any external components	350 mA @24V
Max. current consumption for each SFP connected	36mA @24V
Max. current consumption, APMB_SFP4 board	36 mA @24V
Max. current consumption for each active isolated input	6.6 mA @24V
Max. current consumption for each active isolated output (contact current is not included)	1.8 mA @24V
Max. current consumption for each active relay (contact current is not included)	7.2 mA @24V
Max. current on encoder power output	0-1000 mA @5V 0-240 mA @24V
Operating free-air temperature (Use a fan above this temperature)	0-45°C

TABLE 14 -INPUT POWER SPECIFICATIONS

Notice that output stages of 24V relays are connected directly to input power and current drawn by external components connected to relays are not included in the table.



6 Mechanical Dimensions

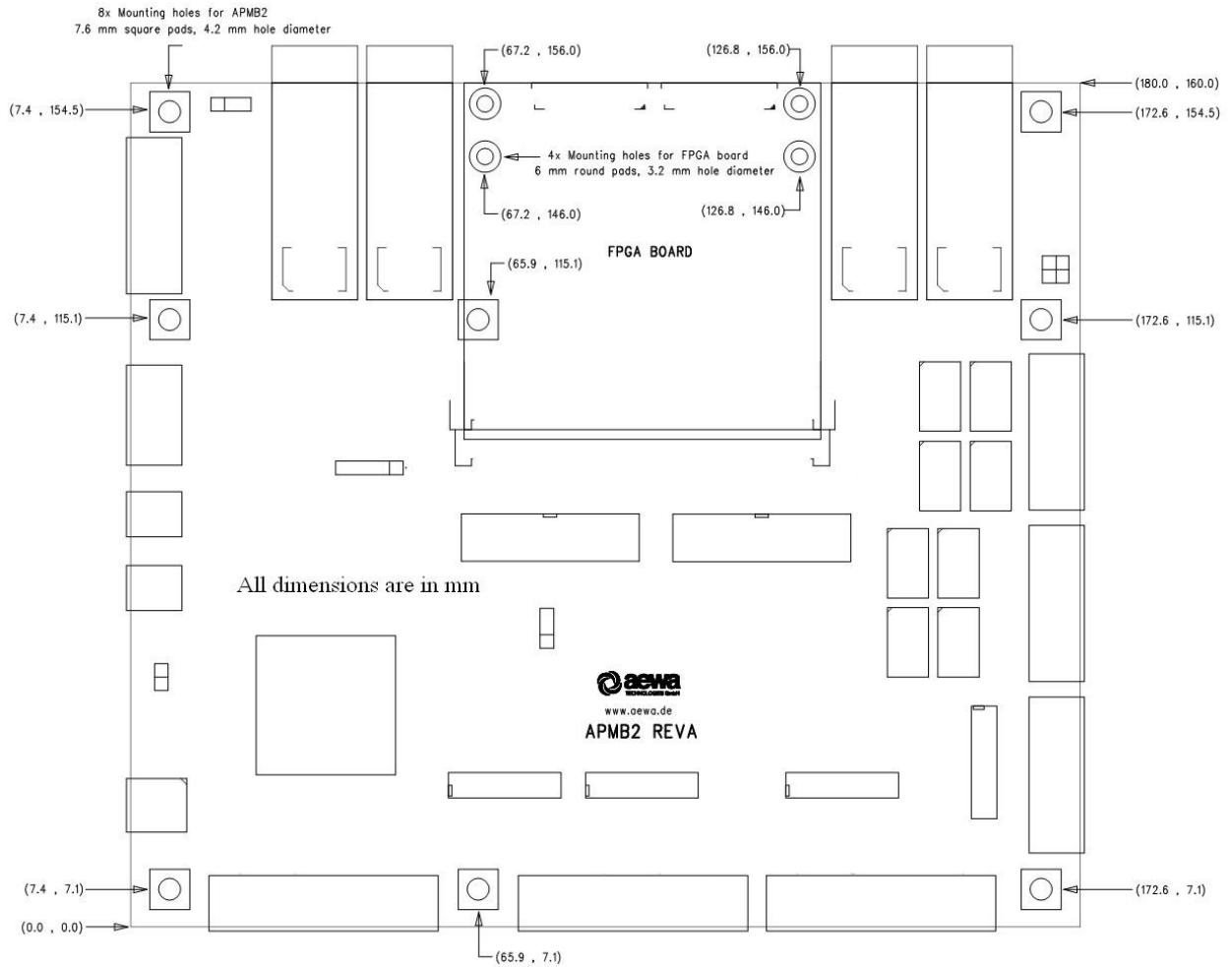


IMAGE 12 - APMB2 MECHANICAL DIMENSIONS



7 Connectors

APMB2 is assembled with very high quality industrial terminal block 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 with screw attachment. Please see the manufacturer datasheets for other types.

Connector Ref. des.	PCB Connector	Mating connector
SK1 (power in)	Phoenix Contact, 5.08 mm raster MSTBA 2,5/ 2-G-5,08 Order No: 1757242	Phoenix Contact, 5.08 mm raster MSTB 2,5/ 2-ST-5,08 Order No: 1757019
SK18, SK20	Weidmüller, 3.5mm raster, 2 pins SL 3.50/02/90G Order No: 1605070000	Weidmüller, 3.5mm raster, 2 pins BL 3.50/02/180 SN or BX Order No: 1597360000
SK16	Weidmüller, 3.5mm raster, 5 pins SL 3.50/05/90G Order No: 1605100000	Weidmüller, 3.5mm raster, 5 pins BL 3.50/05/180 SN or BX Order No: 1597390000
SK10, SK13, SK14, SK15	Weidmüller, 3.5mm raster, 8 pins SL 3.50/08/90G Order No: 1605130000	Weidmüller, 3.5mm raster, 8 pins BL 3.50/08/180 SN or BX Order No: 1597420000
SK7, SK8, SK9	Weidmüller, 3.5mm raster, 12 pins SL 3.50/12/90G Order No: 1605170000	Weidmüller, 3.5mm raster, 12 pins BL 3.50/12/180 SN or BX Order No: 1597460000

TABLE 15 – CONNECTORS



8 Ordering Information

APMB2 can be ordered with the ordering number:

APMB2-FFF-X

Where:

X is the number of head boards supported (1 to 8).

FFF is the host interface (USB: USB 3.0, GBE: 1-Gigabit Ethernet, 10G: 10-Gigabit Ethernet).

Notice that the standard firmware supports always 8 head boards, but delivered with different number of SFP optical transceivers depending on X.

