Revision:	02
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Prepared by:	Schiller Anastasia
Approved by:	AG E-KAZ

This document is valid for the following part numbers:

- L5066401 SKiiP®4 F-Option with D-Sub connector, no plastic case
- L5066402 SKiiP®4 F-Option with D-Sub connector
- L5066403 SKiiP®4 F-Option without D-Sub connector

Technical Explanation SKiiP®4 F-Option Board

Please note:
Unless otherwise specified, all values in this technical explanation are typical values. Typical values are the average values expected in large quantities and are provided for information purposes only. These values can and do vary in different applications. All operating parameters should be validated by user's technical experts for each application.
The document remains effective until replaced by subsequent revision of this document.

Table of content:

1 Related documents

- Technical Explanation SKiiP®4, Rev. 3
- CANopen User Manual Rev.6
- Data sheets SKiiP®4
- Data sheets SKiiP®4 F-Option
- Data sheets SKHBP SKiiP®4
- Technical Explanation SKiiP®4 Parallel Board

2 Application and handling instructions

- Please provide static discharge protection during handling. As long as the board is not completely assembled, the input terminals have to be short-circuited. Persons working with devices have to wear a grounded bracelet. Any synthetic floor coverings must not be statically chargeable. Even during transportation the input terminals have to be short-circuited using, for example, conductive rubber. Worktables have to be grounded.
- When first operating a newly developed circuit, SEMIKRON recommends to apply low collector voltage and load current in the beginning and to increase these values gradually, observing the turn-off behavior of the free-wheeling diode and the turn-off voltage spikes generated across the IGBT. An oscillographic control will be necessary. Additionally, the case temperature of the module has to be monitored. When the circuit works correctly under rated operation conditions, short-circuit testing may be done, starting again with low collector voltage.
- It is important to feed any errors back to the control circuit and to switch off the device immediately in failure events. Repeated turn-on of the IGBT into a short circuit with a high frequency may destroy the device.

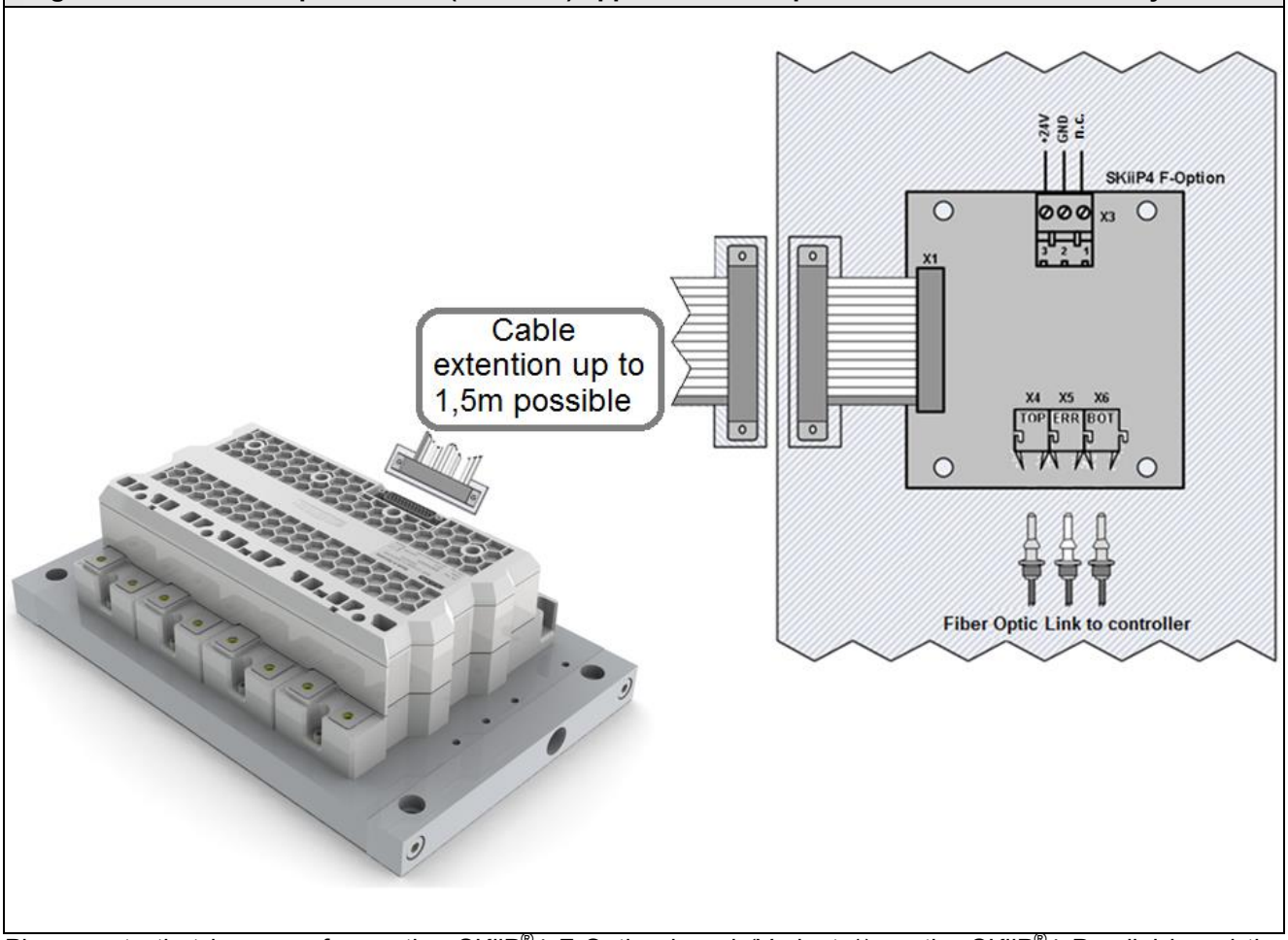
3 General description

The SKiiP®4 F-Option Board allows the controlling of SKiiP®4 system by means of fiber optics. There are three variants of SKiiP®4 F-Option available:

- Variant 1: L5066401 SKiiP®4 F-Option with D-Sub connector, no plastic case
- Variant 2: L5066402 SKiiP®4 F-Option with D-Sub connector
- Variant 3: L5066403 SKiiP®4 F-Option without D-Sub connector

In case of using SKiiP®4 F-Option the two switching signals (TOP/BOT) and the GPIO error signal are transferred via optical connection. In addition the analogue signals as well as the CAN-Bus signals are available on the D-Sub connector X2 for Variants 1 and 2 of F-option boards described above.
The electrical connection between SKiiP®4 F-Option board and SKiiP®4 driver must be realized by 25-wired ribbon cable. The built-in connector of the SKiiP®4 F-Option board can be directly plugged in case of mounting SKiiP®4 F-Option on the SKiiP®4 top cover (Variants 2 and 3) or on SKiiP®4 Paralleling Board (Variant 1). In other cases the usage of cable extention up to 1,5m is allowed. On the other side it must always be connected to the SEMIKRON “SKiFace Standard” interface of SKiiP®4 driver by a 25-pin D-Sub female connector. Please refer to the Technical Explanation SKiiP®4 for pin assignment of connector X1.
The example of SKiiP®4 F-Option board application for Variant 1 is shown in the Figure 3.1.

Figure 3.1: SKiiP4 F-Option board (Variant 1) application example with connected SKiiP®4 system



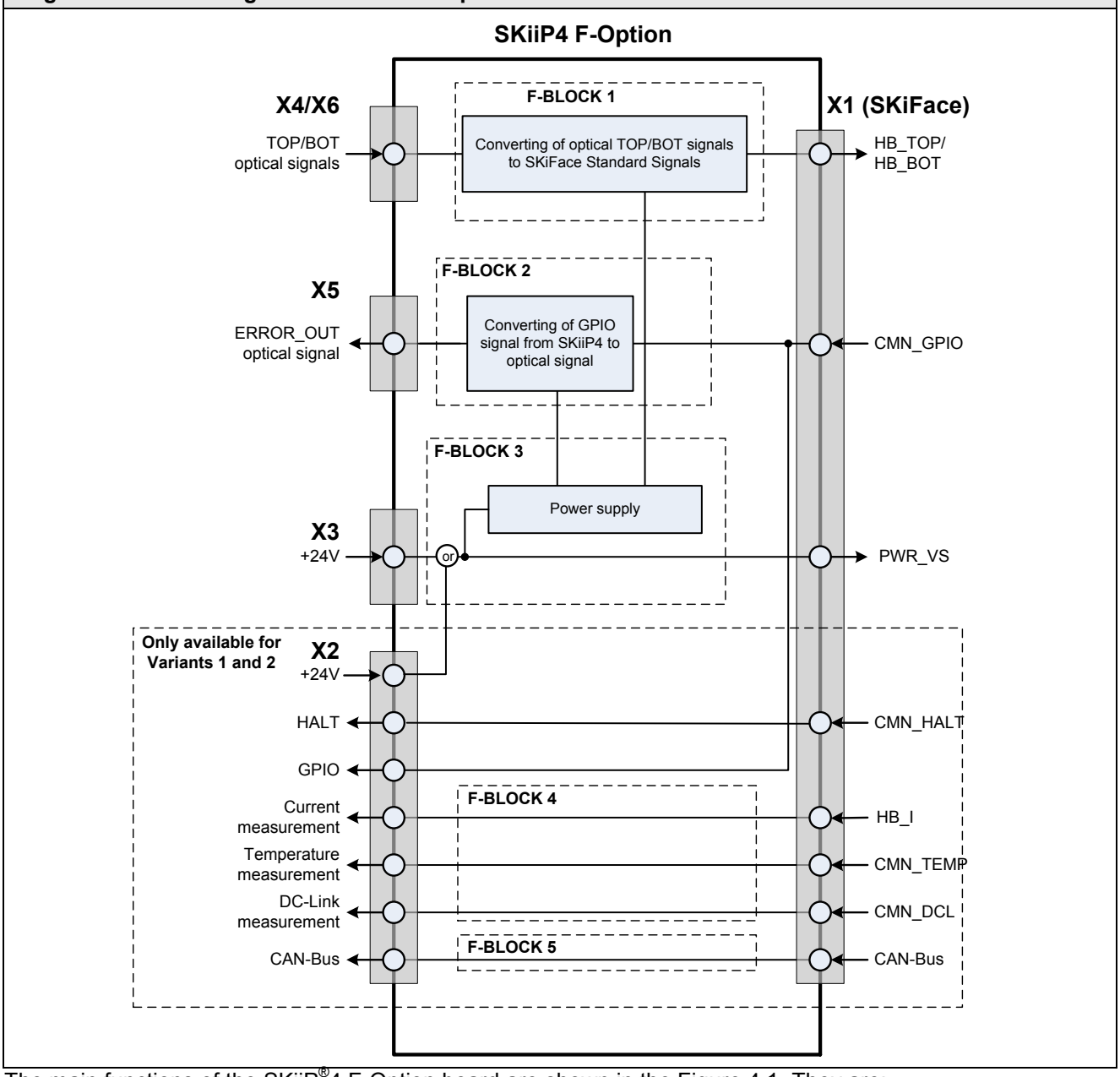
Please note that in case of mounting SKiiP®4 F-Option board (Variant 1) on the SKiiP®4 Parallel board the SKiiP®4 Parallel board variant compatible to the F-Option board should be chosen. The following SKiiP®4 Parallel boards are compatible to the F-Option Board (Variant 1):

- L5064204 (paralleling of 4 SKiiP®4 systems),
- L5064205 (paralleling of 3 SKiiP®4 systems),
- L5064206 (paralleling of 2 SKiiP®4 systems).

Pollution degree class 2 and IP00 shall be considered for all SKiiP®4 F-Option boards.

4 Block diagram

Figure 4.1: Block diagram of SKiiP®4 F-Option board main functions



The main functions of the SKiiP®4 F-Option board are shown in the Figure 4.1. They are:

- F-Block 1: Converting the optical TOP/BOT switching signals from the connectors X4/X6 to the SKiiP®4 connector X1
- F-Block 2: Converting the GPIO signal from SKiiP®4 connector X1 to optical error signal ERROR_OUT at connector X5
- F-Block 3: +24V power supply

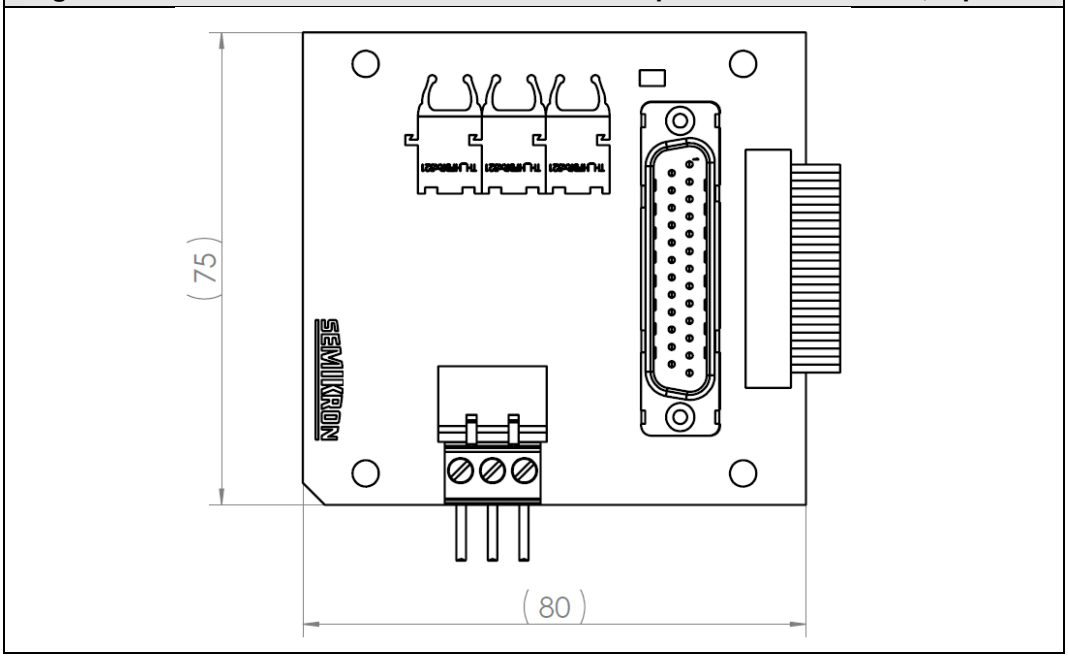
The F-Blocks 4 and 5 as well as +24V routing from controller connector X2 to SKiiP®4 connector X1 (please see Chapter 9 for details) are available only for F-Option Variants 1 and 2:

- F-Block 4: Forwarding of analogue signals from SKiiP®4 connector X1 to F-Option D-Sub connector X2
- F-Block 5: Forwarding of CAN-Bus signals from SKiiP®4 connector X1 to F-Option D-Sub connector X2
- HALT and GPIO Signals are available on the F-Option D-Sub connector X2 as well.

5 Dimensions

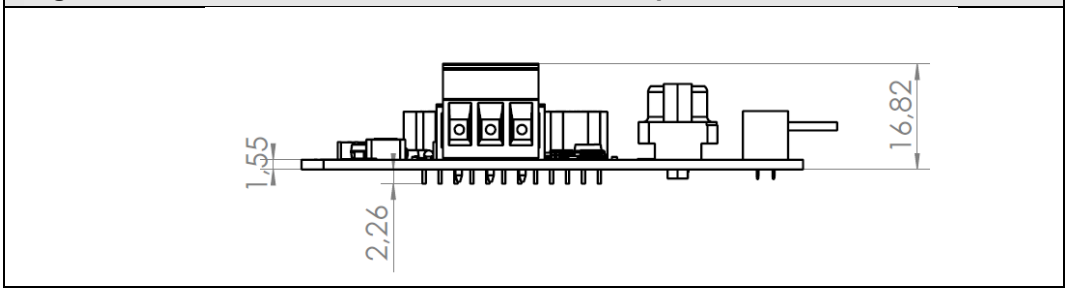
The mechanical dimensions of SKiiP®4 F-Option board Variant 1, top view are shown in the Figure 5.1.

Figure 5.1: Mechanical dimensions of SKiiP®4 F-option board Variant 1, top view



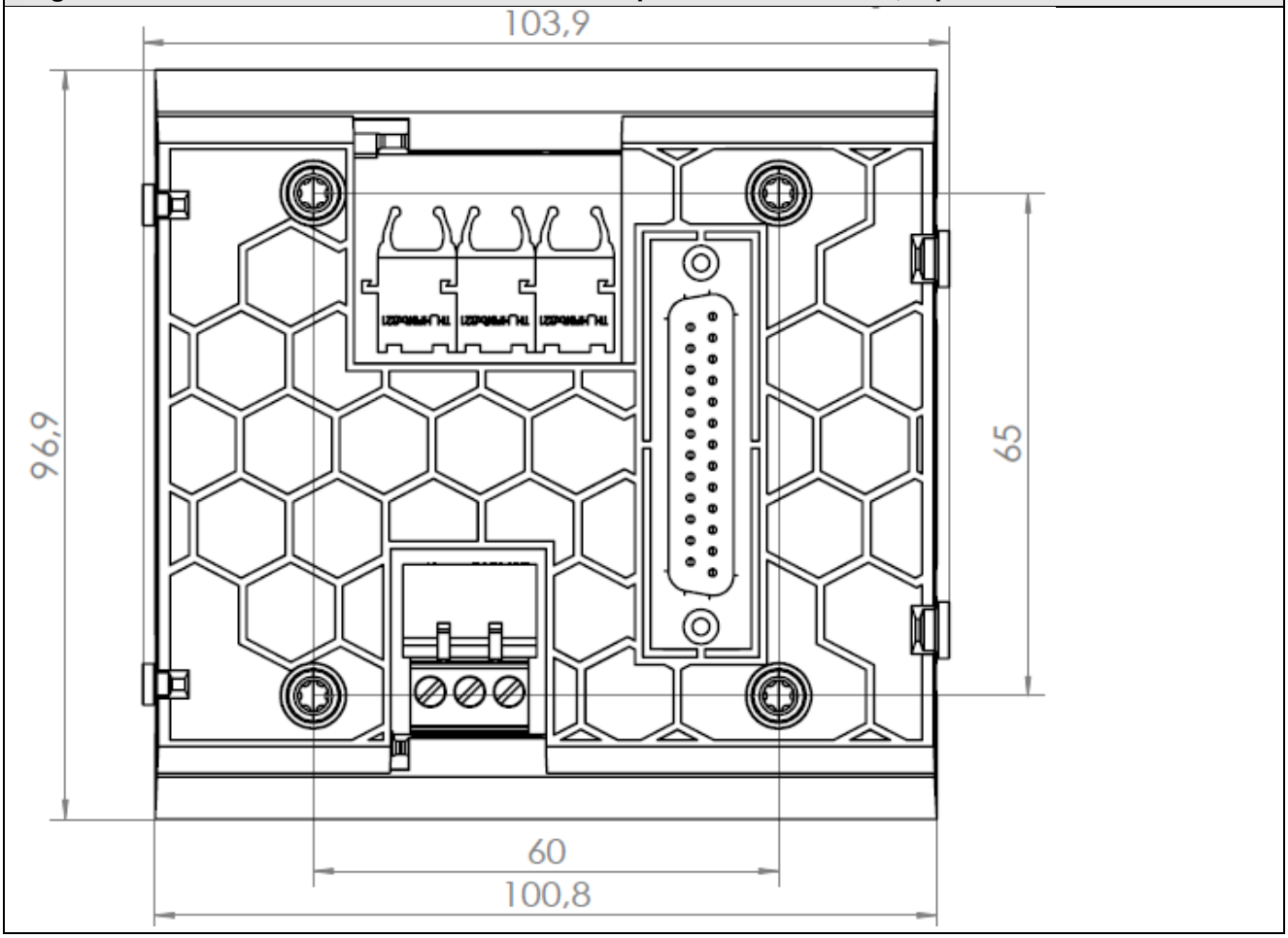
The mechanical dimensions of SKiiP®4 F-Option board Variant 1, side view are shown in the Figure 5.6.

Figure 5.2: Mechanical dimensions of SKiiP®4 F-option board Variant 1, side view



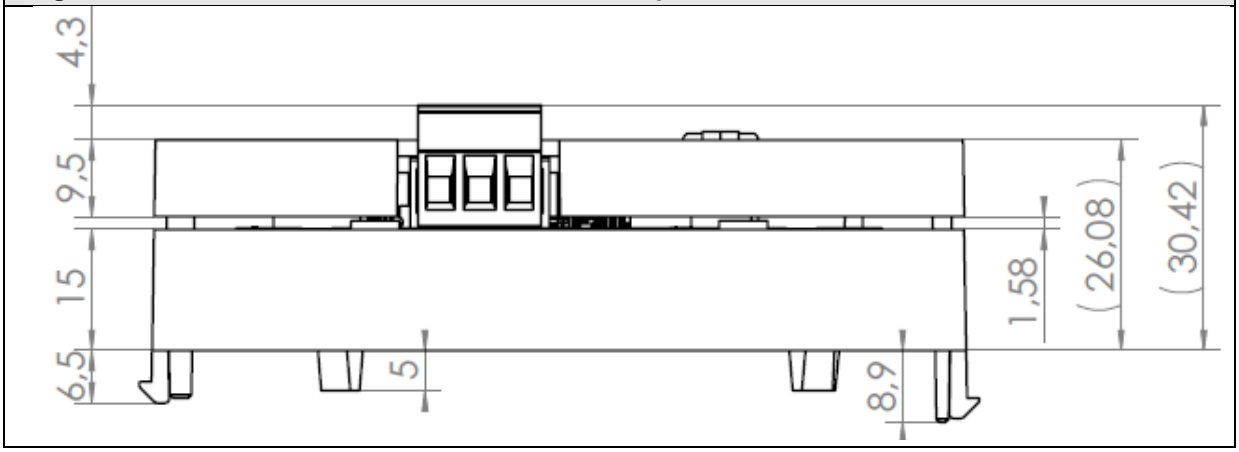
The mechanical dimensions of SKiiP®4 F-Option board Variant 2, top view are shown in the Figure 5.3.

Figure 5.3: Mechanical dimensions of SKiiP®4 F-option board Variant 2, top view



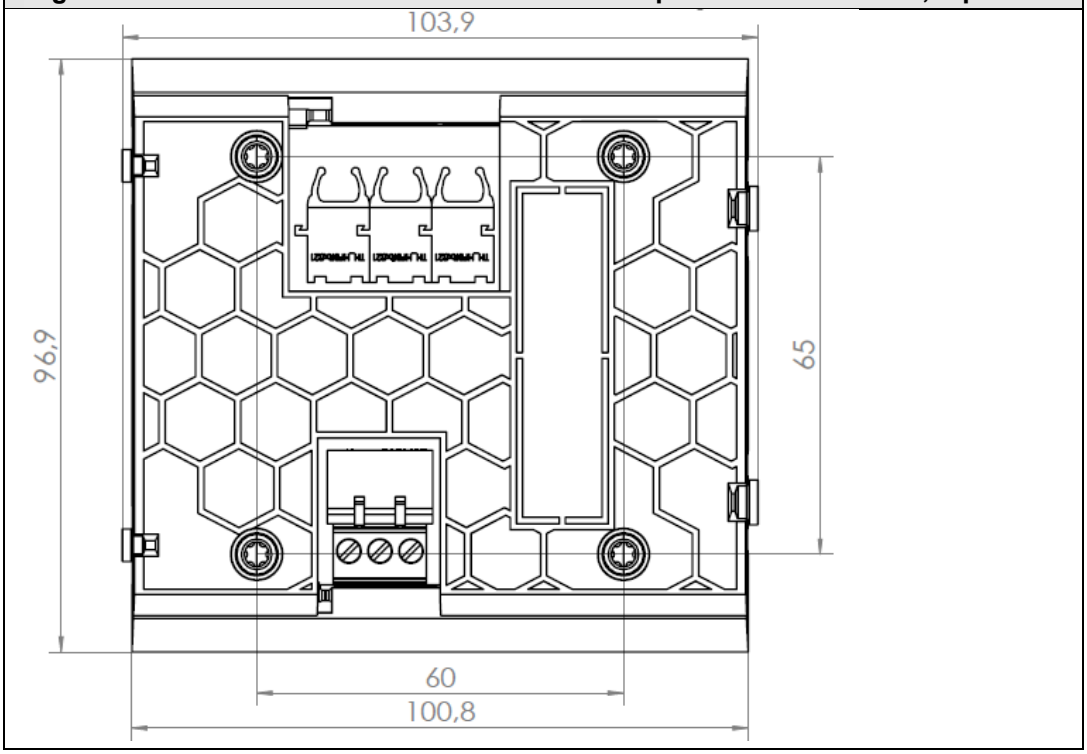
The mechanical dimensions of SKiiP®4 F-Option board Variant 2, side view are shown in the Figure 5.4.

Figure 5.4: Mechanical dimensions of SKiiP®4 F-option board Variant 2, side view



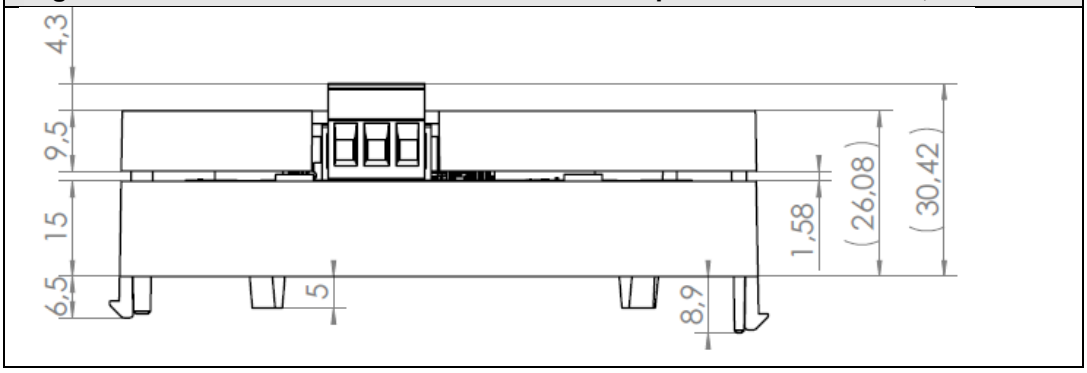
The mechanical dimensions of SKiiP®4 F-Option board Variant 3, top view are shown in the Figure 5.5.

Figure 5.5: Mechanical dimensions of SKiiP®4 F-option board Variant 3, top view



The mechanical dimensions of SKiiP®4 F-Option board Variant 3, side view are shown in the Figure 5.6.

Figure 5.6: Mechanical dimensions of SKiiP®4 F-option board Variant 3, side view



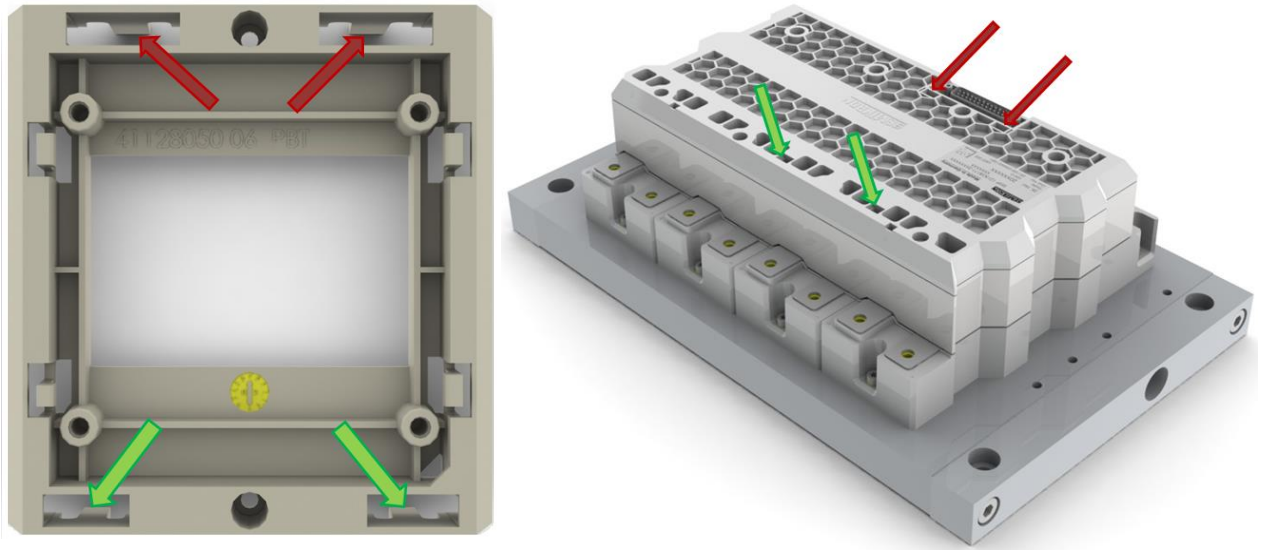
6 Mounting Instruction

6.1 Mounting Instruction for F-Option Board Variants 2 and 3

The mounting process for both Variants 2 and 3 is identic, the description below is shown on example of F-Option board Variants 2.
The F-Option plastic housing consists of two parts: bottom part (Figure 6.1, left) and top cover (Figure 6.3, left).

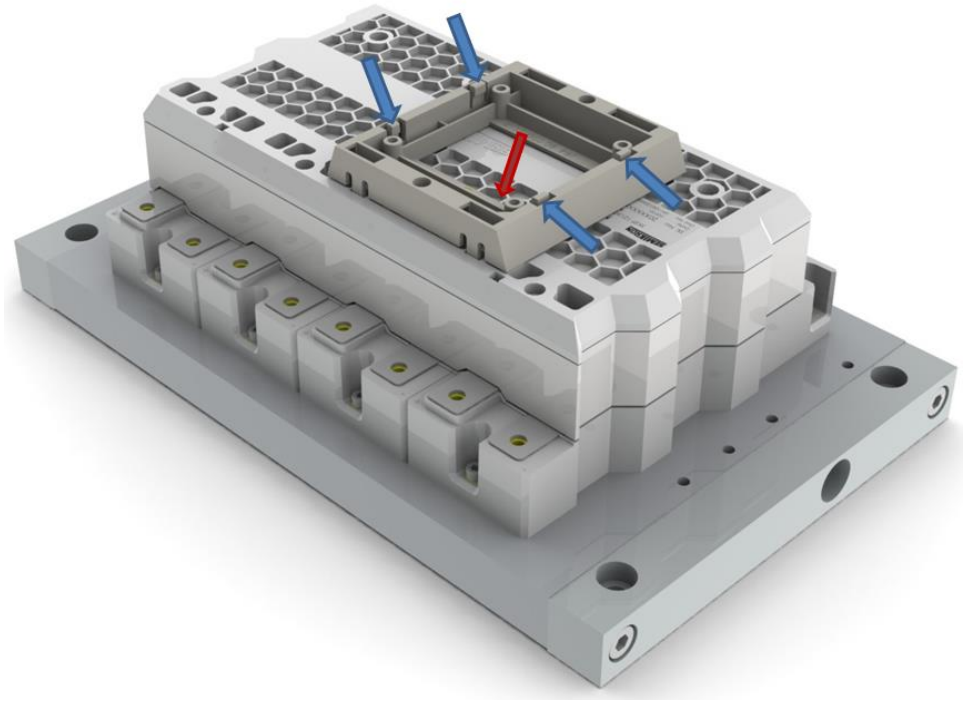
1. The bottom part should be placed on the SKiiP®4 top cover so that the snap-fits with larger distance (see green arrows Figure 6.1) match to the slots of SKiiP®4 top cover. Afterwards the other side should be pressed inside applying slight pressure (see red arrows Figure 6.1) till the click is audible.

Figure 6.1: Mounting of bottom part of plastic cover SKiiP4 F-option board



2. The PCB can now be inserted in the bottom part of the F-Option housing (Figure 6.2), where it will be fixed by pressure parts at the sides (see blue arrows Figure 6.2). One edge of the PCB and housing is cut off (see red arrow Figure 6.2) to avoid the reversed placing of PCB. It is recommended to insert the PCB into the housing at the beginning on one side and then to press it inside on the other side applying slight pressure. Please check the screw holes on PCB match to the holes of bottom part of plastic cover.

Figure 6.2: Inserting of the PCB inside the plastic cover



3. The next step is mounting of the top part of the plastic housing SKiiP®4 F-Option. Please take care that the snap-fits of bottom part match to the snap-fits of the top cover of the housing (see red arrows Figure 6.3, the cable connection between F-option Board and SKiiP®4 is not shown).

Figure 6.3: Mounting of the top part of the plastic cover SKiiP®4 F-option board

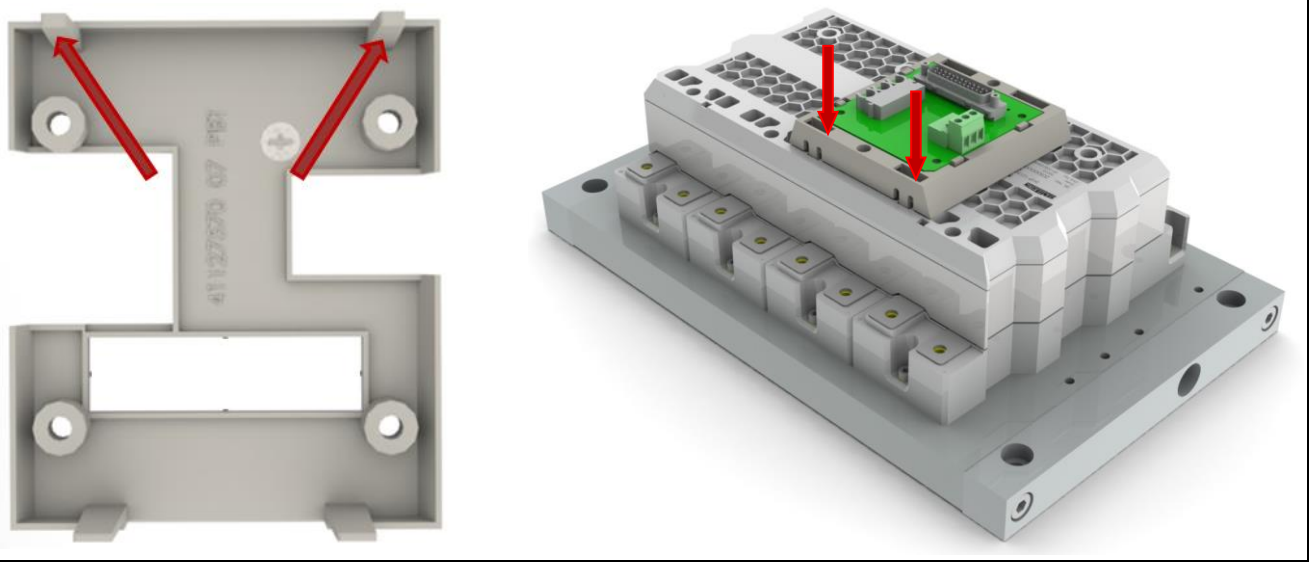
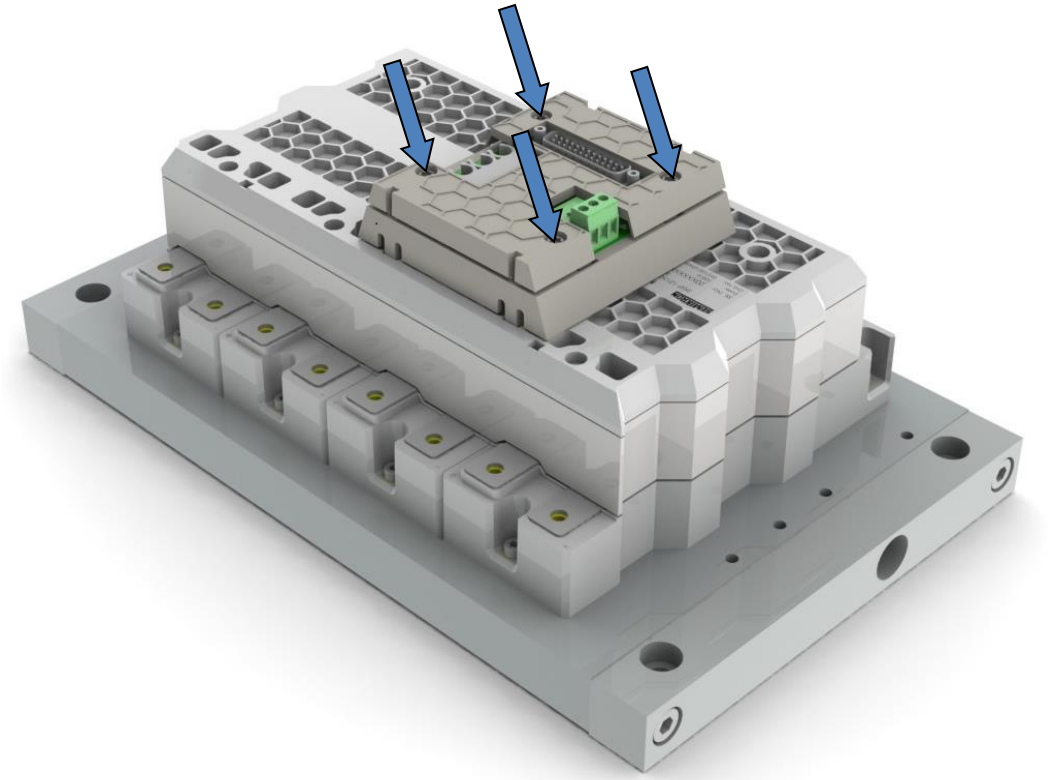


Figure 6.4: Mounting of the top part of the plastic cover SKiiP®4 F-option board, final view



4. The PCB should now be fixed with 4 screws Ejot Delta PT 40x18 T20, order number: 4230435809, in the bottom part of the F-Option housing (please see Figure 6.4, blue arrows). Please use the screws included in delivery. The screwing parameters should be set up as follows:
   Screwer to be used (Bit): T20 Torx
   Rpm: 500 – 600 U\min
   Torque for the first time screwing: 1,8 Nm
   Torque for the next screwing (manually, without rpm control): 1,2 - 1,4 Nm
   By inadequate setting of screwing parameters mounting problems can occur, e.g. loosing of top cover or thread damage.

6.2 Mounting Instruction for F-Option Board Variant 1

Please refer to the Technical Explanation SKiiP®4 Parallel Board for information about mounting of F-Option SKiiP®4 Variant 1 on the SKiiP®4 Parallel Board.
It is also possible to use F-Option SKiiP®4 Variant 1 as a spare part replacement for Varant 2. In this case it must be inserted into the plastic housing as decribed in the chapter 6.1.

7 Description of D-Sub connector X2

7.1 Pin Description

Please refer to SKiiP®4 Technical Explanation Rev.3 Chapter 5.2 “Gate driver interface SkiFace” for further information and pin out of connector X2.

Please note: Pin 8 HB TOP and pin 21 HB BOT are not connected!

7.2 Not used Signals

For more details please see Technical Explanation SKiiP®4 Rev.3 Chapter 5.2.11 ”Reserved or not used signals”.

8 Pin Description of optical connectors X4, X5, X6

Table 1: Description of optical connectors X4, X5, X6		
Connector	Type	Signal description
X4	Optical Receiver • Type: HFBR-2521ETZ, horizontal	Receives the PWM control signal for TOP-IGBT from the controller
X5	Optical Transmitter • Type: HFBR-1521ETZ, horizontal	Transmits the GPIO error signal from SKiiP4 driver to controller
X6	Optical Receiver • Type: HFBR-2521ETZ, horizontal	Receives the PWM control signal for BOT-IGBT from the controller

The following fiber optical cable type was used for the qualification: Leoni KHPS-HPS11005m. This fiber optic cable consists of:

- 2 optical connectors SXHP-SSO-19-0040 (incl. crimp barrel)
- 5m long optical fiber cable V2Y 1P980/1000.

9 Power Supply

Please note: The supply voltage for SKiiP®4 F-Option Board and SKiiP®4 system can be provided over power supply connector X2 if the voltage drop over the ribbon cable will not be too high due to the supply current (please see data sheet SKiiP®4 for supply current formula). Otherwise supply connector X3 should be used.

Please refer to SKiiP®4 Technical Explanation Rev.3 Chapter 5.2 “Gate driver interface SkiFace” for further information and pin out of connector X2.
The pin assignment of power supply connector X3 is shown in the Table 2.

Table 2: Power supply connector X3 pin assignment		
Pin	**Signal name**	**Function**
01		n.c.
02	GND	Ground
03	+24V	Supply voltage input for F-Option Board and SKiiP®4

Table 3 shows the required features of an appropriate power supply for a SKiiP®4 system.

Table 3: Requirements of the power supply	
Power supply	Supply voltage should be +24V (+/- 20%). The supply is defined at the F-Option Board input.
Maximum rise time of 24V	< 2s
Rated current	1.5 times of the maximum SKiiP driver input current
Minimum peak	2 times of the maximum SKiiP driver input current (at least 1,5A)

For further information please refer to the Technical Explanation SKiiP®4.

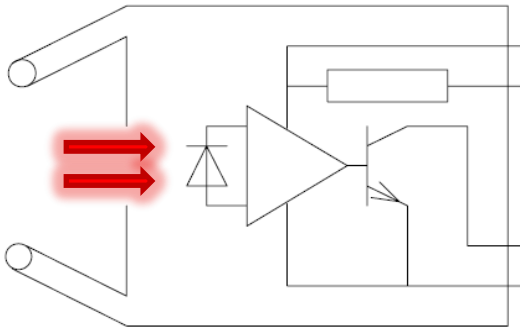
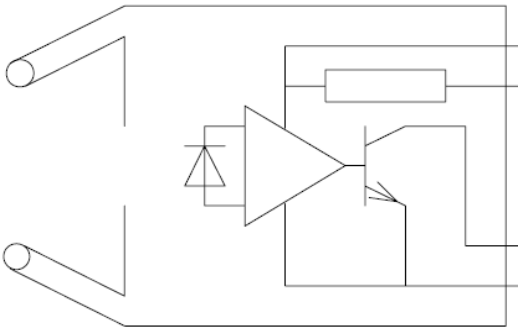
Please note: Power supply cable should be twisted or shielded to enhance the EMI robustness.

10 Optical Input/Output Signals

10.1 PWM TOP/BOT Signals

The PWM TOP/BOT optical signals could be described as follow: by recognised incoming light the IGBT will be switched on, by no light the IGBTwill be switched off. Please see Table 4.

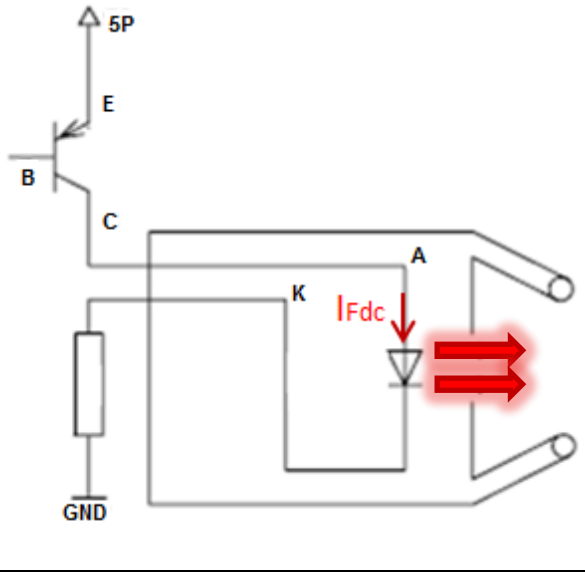
Table 4: PWM TOP/BOT optical signals

Optical Receiver receives light	Optical Receiver receives no light
	
IGBT ON	IGBT OFF

Please note: A non-connected optical link will be considered as LOW signal (IGBT OFF).

If the light intensity is not sufficient the IGBT might stay off and an ERROR_OUT signal might be set. To avoid this the minimal transmitter current I_{Fdc} at the controller side should be at least 50 mA. Please see Figure 10.1 for example of the circuit for transmitter LED at the controller side.

Figure 10.1:Transmitter current controller side

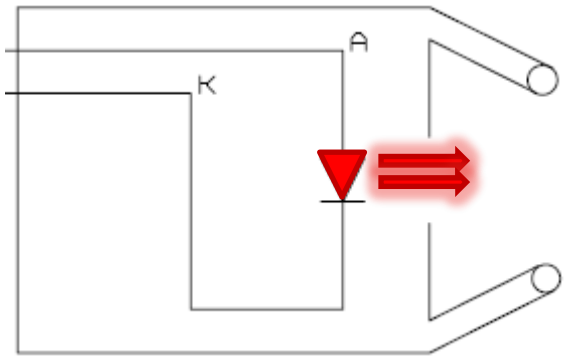
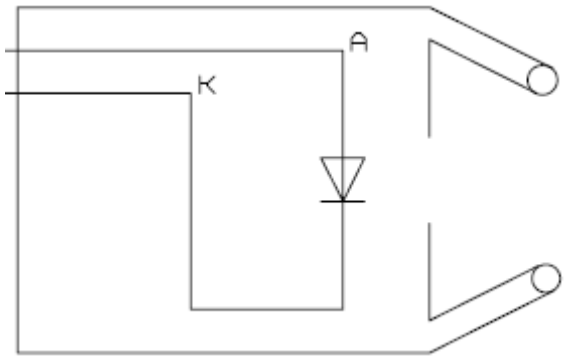


10.2 ERROR_OUT Signal

Characteristics and functionality:

- Shows the status of the IGBT driver
- For ERROR_OUT logic please see Table 5.

Table 5: ERROR_OUT optical signal

Optical Transmitterr emits light	Optical Transmitter emits no light
	
No error	Error

The connected SKiiP®4 system sets the ERROR-OUT signal (Optical transmitter emits no light) if following happens:

- the unit is not ready to operate
- error happened

Please refer to the SKiiP®4 Technical Explanation Rev.3 chapter “GPIO -Signal” for further information.

11 D-Sub Connector signals

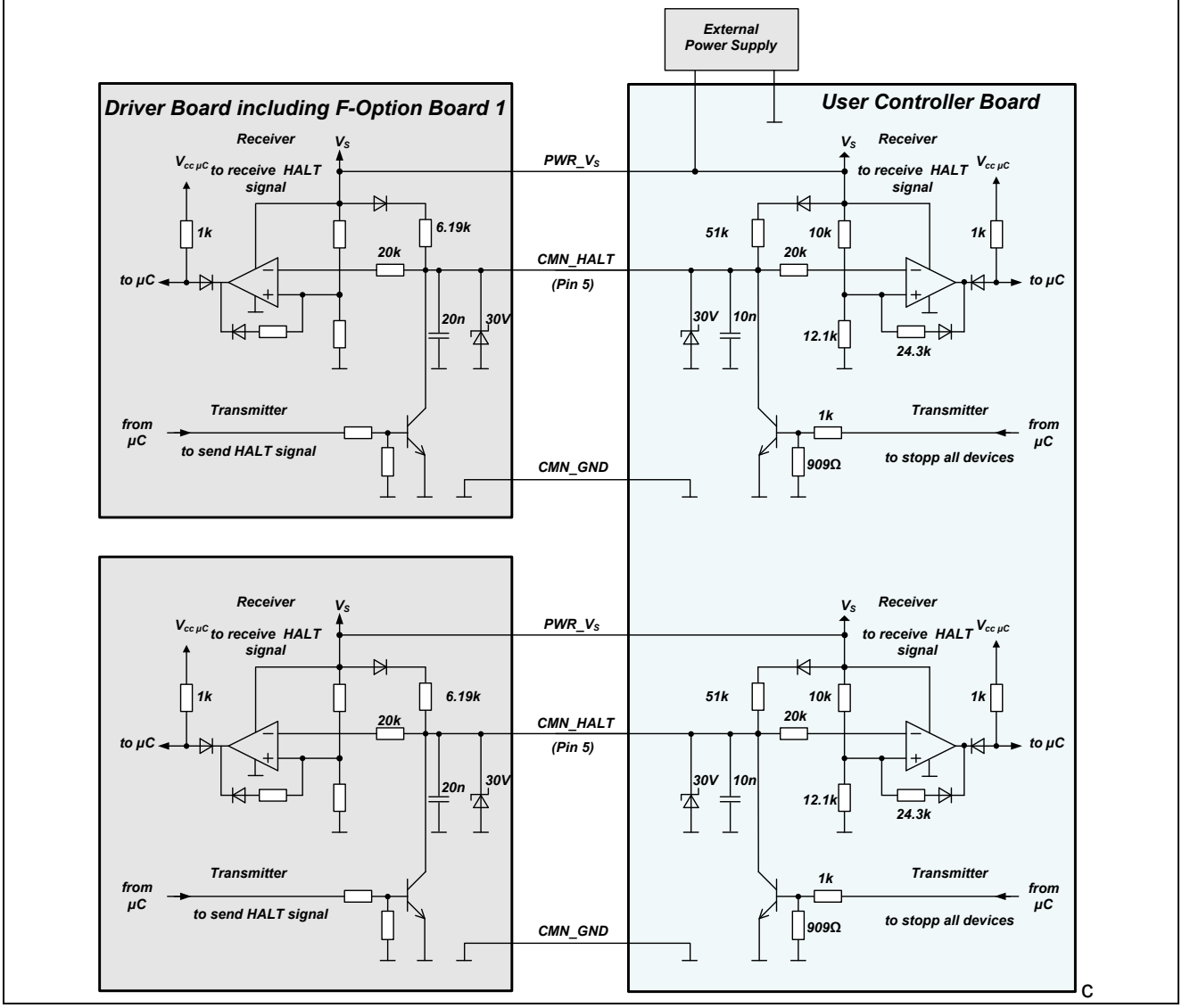
Please note: D-Sub connector signals are available only for SKiiP®4 F-Option Board Variants 1 and 2.

11.1 HALT Signal

Figure 11.1 depicts:

- on the left hand side the Input/Output stage of the CMN_HALT signal
- on the right hand side an example of the input stage on the user controller board for each CMN_HALT output of several SKiiP®4 with F-Option Boards.

Figure 11.1: Application example of the HALT signal



The HALT signals of all SKiiPs in the application and from other hardware components can also be connected together. That means that the HALT signal is set to LOW state when one of the connected SKiiPs is not ready to operate. In this case only one receiver circuit on the user controller board is necessary. In case of failure the switch off time for all such connected susystems will be shorter, than for SKiiPs with separately processed HALT-signals.

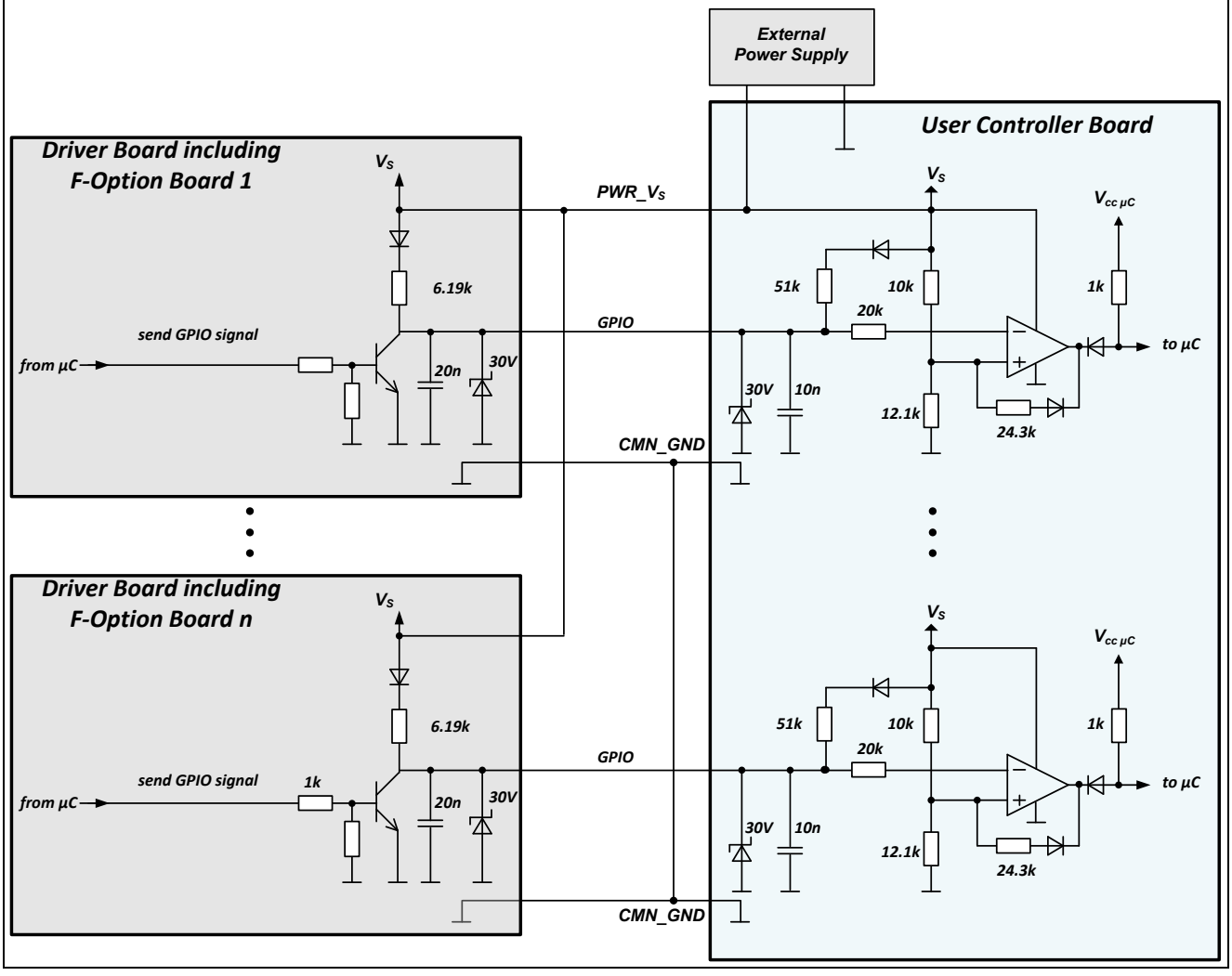
Please note: maximal number of devices for paralleling of HALT signal is 6 items.

11.2 GPIO Signal

Figure 11.2 depicts:

- on the left hand side the output stage of the CMN_GPIO signal
- on the right hand side an example of the input stage on the user controller board for each CMN_GPIO output of several SKiiP®4 with F-Option Boards.

Figure 11.2: Application example of the CMN_GPIO (inverted HALT signal) as error output signal



11.3 Analogue Signals

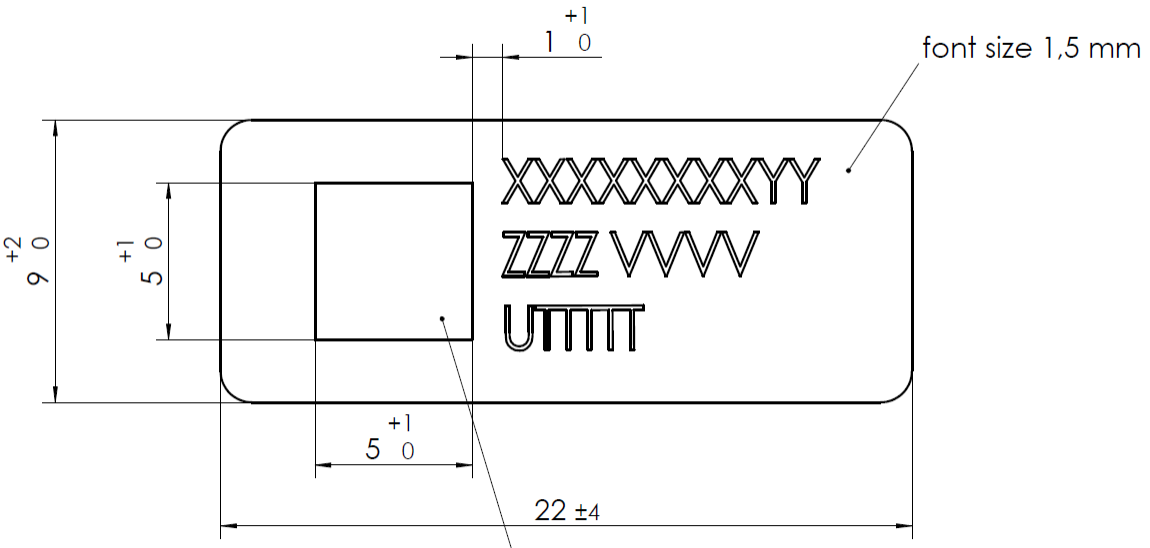
F-Option Board with D-Sub-Connector forwards analogue signals without any changes. For signal characteristics and further information please see Technical Explanation SKiiP®4 Rev.3 Chapter 5.3.8.

11.4 CAN Signals

F-Option Board with D-Sub-Connector forwards CAN signals without any changes. For more details please see Technical Explanation SKiiP®4 Rev.3 Chapter 5.2.8 as well as the CANopen User Manual Rev.6.

12 Logistics

Figure 12.1: Part Marking Information



Data-Matrix area:
max. 34 signs
cell dimension 0,254 - 0,3 mm
scan distance: 60-100mm
scan angle max 30 degrees of perpendicular angle

lettering Data-Matrix area:

XXXXXXXXYYZZZZVVVVUTTTTT
(L5022001NF04400001054229 for instance)

- accounts payable number (5-digit)
- country code (1-digit)
- continuous Lot-Nr. referenced to date code (4-digit)
- date code for instance 0440 year/week (4-digit)
- release of the Ident Nr. (2-digit)
- Ident Nr. (8-digit)

Label:
PE - foil (white sheeny) z.B. 0500XE-TT from manufacturer Förster-Etikettendruck
Operating temperature: min -40°C / max +100°C
Overprint waterproof and varnish resist

13 Provisions and handling after use

Components which are obsolete or defective must be disposed according to local regulations

List of figures:

List of tables:

References

[1] www.SEMIKRON.com
[2] A. Wintrich, U. Nicolai, W. Tursky, T. Reimann, “Application Manual Power Semiconductors”, ISLE Verlag 2011, ISBN 978-3-938843-666

HISTORY

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