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This document is valid for the following part numbers:

- L5064201 SKiiP<sup>®</sup>4 SKHBP4
- L5064202 SKiiP<sup>®</sup>4 SKHBP3
- L5064203 SKiiP<sup>®</sup>4 SKHBP2
- L5064204 SKiiP<sup>®</sup>4 SKHBP4 F-Option compatible
- L5064205 SKiiP<sup>®</sup>4 SKHBP3 F-Option compatible
- L5064206 SKiiP<sup>®</sup>4 SKHBP2 F-Option compatible

with date code (JJWW)  $\geq$  1245

with date code (JJWW)  $\geq$  1635 (differences marked correspondingly)

## Technical Explanation SKiiP<sup>®</sup>4 Parallel 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.

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## 1 Related documents

- Technical Explanation SKiiP<sup>®</sup>4
- Data sheets SKiiP<sup>®</sup>4 Parallel board
- CANopen Object Dictionary Rev.6
- CANopen Interface Documentation
- Data sheets SKiiP<sup>®</sup>4
- Data sheet SKiiP<sup>®</sup>4 F-Option Board
- Data sheet SKiiP<sup>®</sup>4 F-Option Board with D-Sub connector

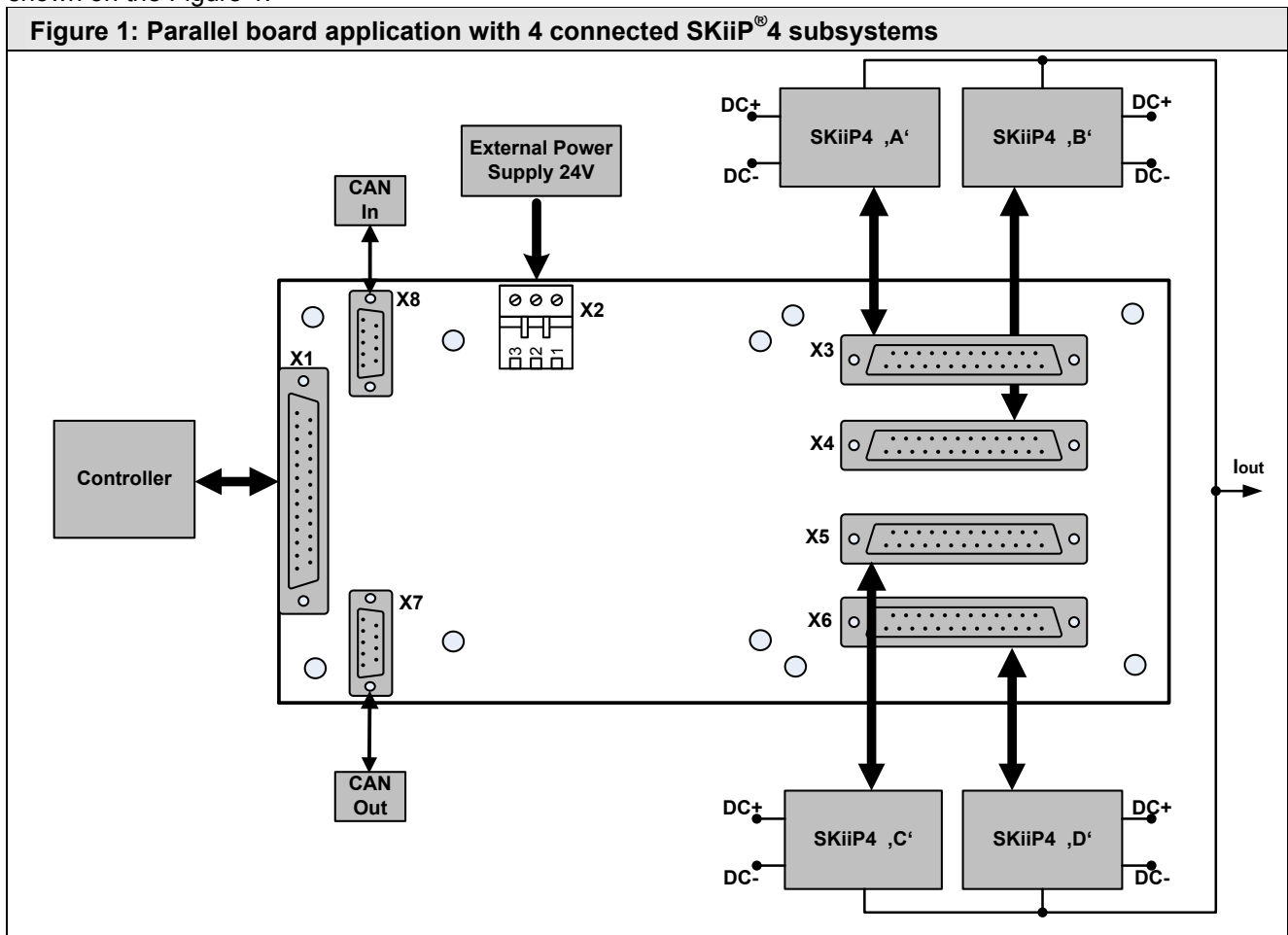
## 2 Application and handling instructions

- 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.
- The inputs of the board are sensitive to overvoltage. Voltages higher than  $V_S + 0,3V$  or below  $-0,3V$  may destroy these inputs. Therefore, control signal overvoltage exceeding the above values has to be avoided.

### 3 General description

#### 3.1 Overview

The SKiiP<sup>®</sup>4 Parallel board supports the controlling of up to SKiiP<sup>®</sup>4 subsystems through only one connector (X1) and each Parallel board is driving one electrical phase ( $I_{out}$ ). The example of Parallel board application is shown on the Figure 1.



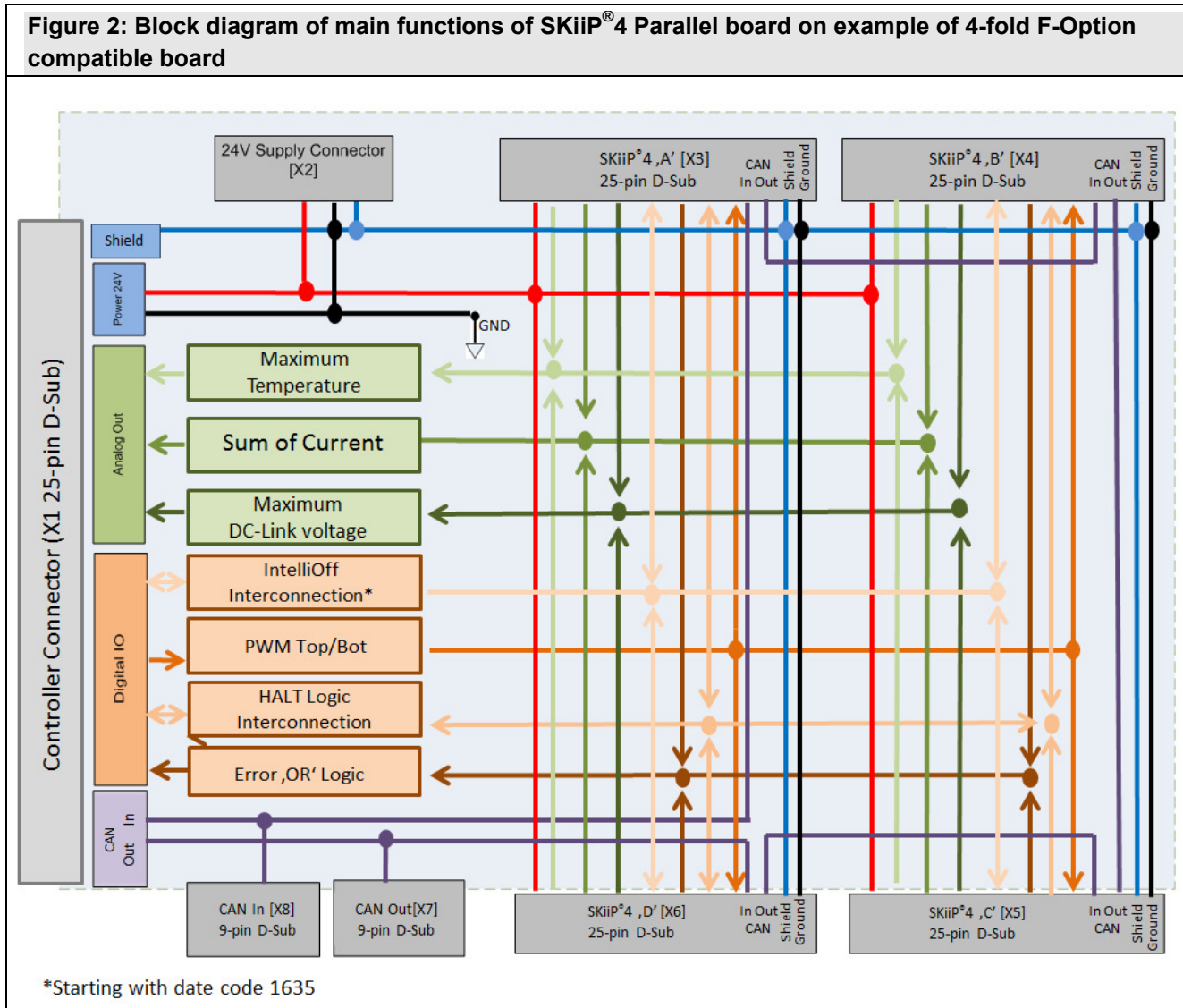
For an EMI-safety transmission of the switching- and error-signals, there is the possibility to mount an optional fiber-adapter (termed: F-Option) on top of the SKiiP<sup>®</sup>4 Parallel board. Please note that in this case the SKiiP<sup>®</sup>4 Parallel board variant compatible to the F-Option board should be chosen (see the variants list below). No mechanical housing is required since the board is directly mounted on a metal frame inside the cabinet.

There are following variants of SKiiP<sup>®</sup>4 Parallel board:

- Board setup for paralleling of two SKiiP<sup>®</sup>4 GB IPM 1200V/1700V w/o F-Option (using connector X3/X4 & horizontal connector X1)
- Board setup for paralleling of two SKiiP<sup>®</sup>4 GB IPM 1200V/1700V with F-Option (using connector X3/X4 & vertical connector X1)
- Board setup for paralleling of three SKiiP<sup>®</sup>4 GB IPM 1200V/1700V w/o F-Option (using connector X3/X4/X5 & horizontal connector X1)
- Board setup for paralleling of three SKiiP<sup>®</sup>4 GB IPM 1200V/1700V with F-Option (using connector X3/X4/X5 & vertical connector X1)
- Board setup for paralleling of four SKiiP<sup>®</sup>4 GB IPM 1200V/1700V w/o F-Option (using connector X3/X4/X5/X6 & horizontal connector X1)
- Board setup for paralleling of four SKiiP<sup>®</sup>4 GB IPM 1200V/1700V with F-Option (using connector X3/X4/X5/X6 & vertical connector X1)

A pollution degree class 2 and IP00 shall be considered for the SKiiP<sup>®</sup>4 Parallel board.

### 4 Block diagram

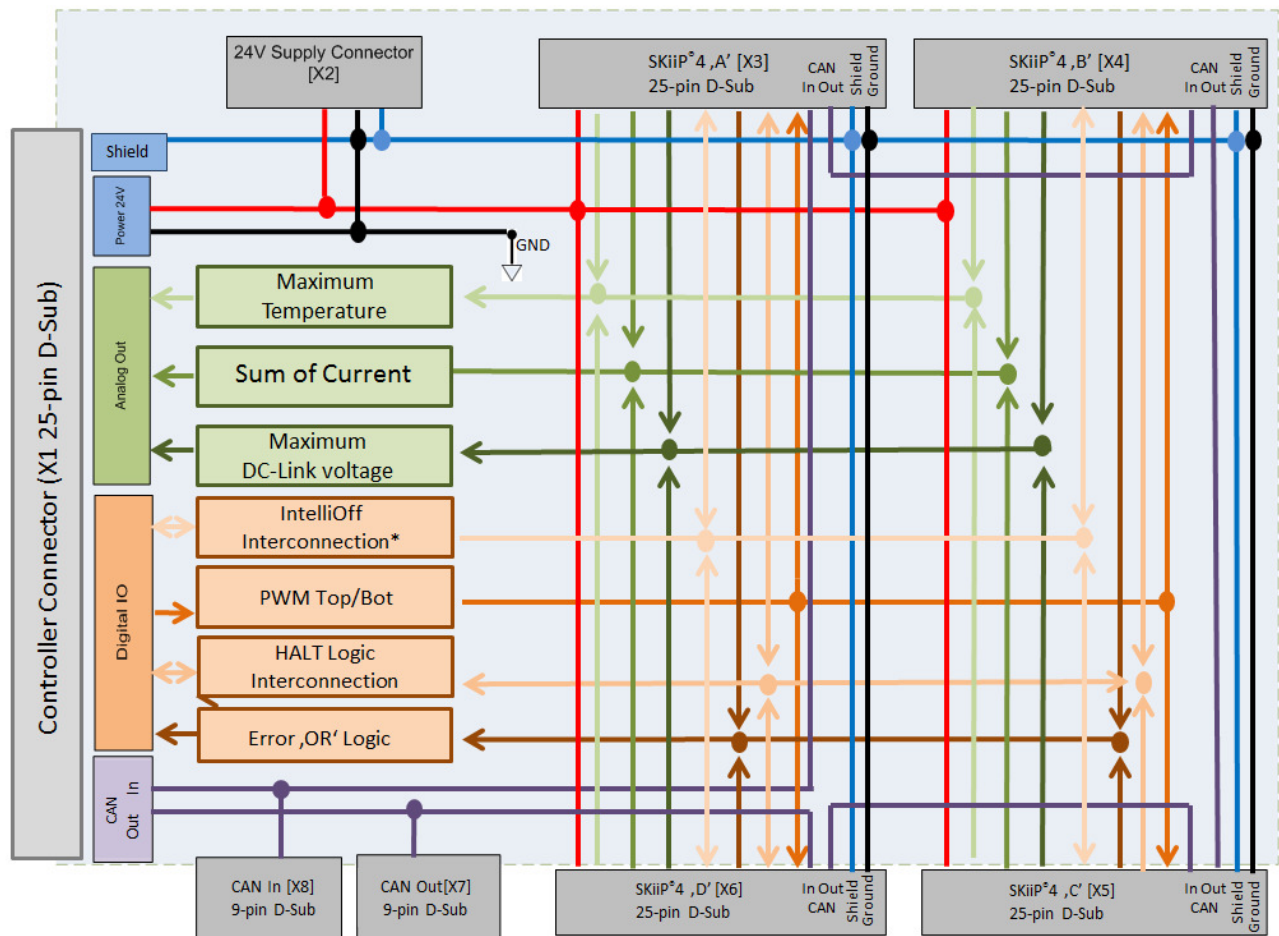


The main functions of the Parallel board are shown in the Figure 2. They are:

- 24V routing from Supply Connector X2 to all 4 SKiiP® 4 D-Sub connectors X3/X4/X5/X6
- Supplying 24V to F-Option board through controller connector X1 is only available for Parallel board setup with F-Option (See Figure 2 and Figure 3)
- Monitoring the +15V; -15V; in case of failure the HALT signal will be activated
- Providing the maximal temperature value of all connected SKiiP® 4 subsystems (Analog Out / connector X1)
- Providing the sum of all AC-currents as analogue signal of all connected SKiiP® 4 subsystems (Analog Out / connector X1)
- Providing the maximal DC-Link voltage as analogue signal of all connected SKiiP® 4 subsystems (Analog Out / connector X1)
- Routing the TOP/BOT switching signals (incl. short-pulse-suppression) from the controller connector X1 to up to all 4 SKiiP® 4 connectors X3/X4/X5/X6
- Combining the 4 HALT signals as well as the +15V-Failure signal, to one bidirectional HALT signal (Digital Out / connector X1)

- Linking the error signals from the connected SKiiP<sup>®</sup>4 subsystems to one error signal (Digital Out / connector X1)
- Routing the CAN bus signals in a Daisy chain Linear Topology from the connector X1 (X7,X8) to the SKiiP<sup>®</sup>4 connector X3/X4/X5/X6
- Starting with date code 1635: supporting of IntelliOff interconnection (See Figure 2/Figure 3). For more details and example of controller board connection please refer to Technical Explanation SKiiP<sup>®</sup>4, Rev.8, Chapter "Pin description", Pin 4: GPIO2.

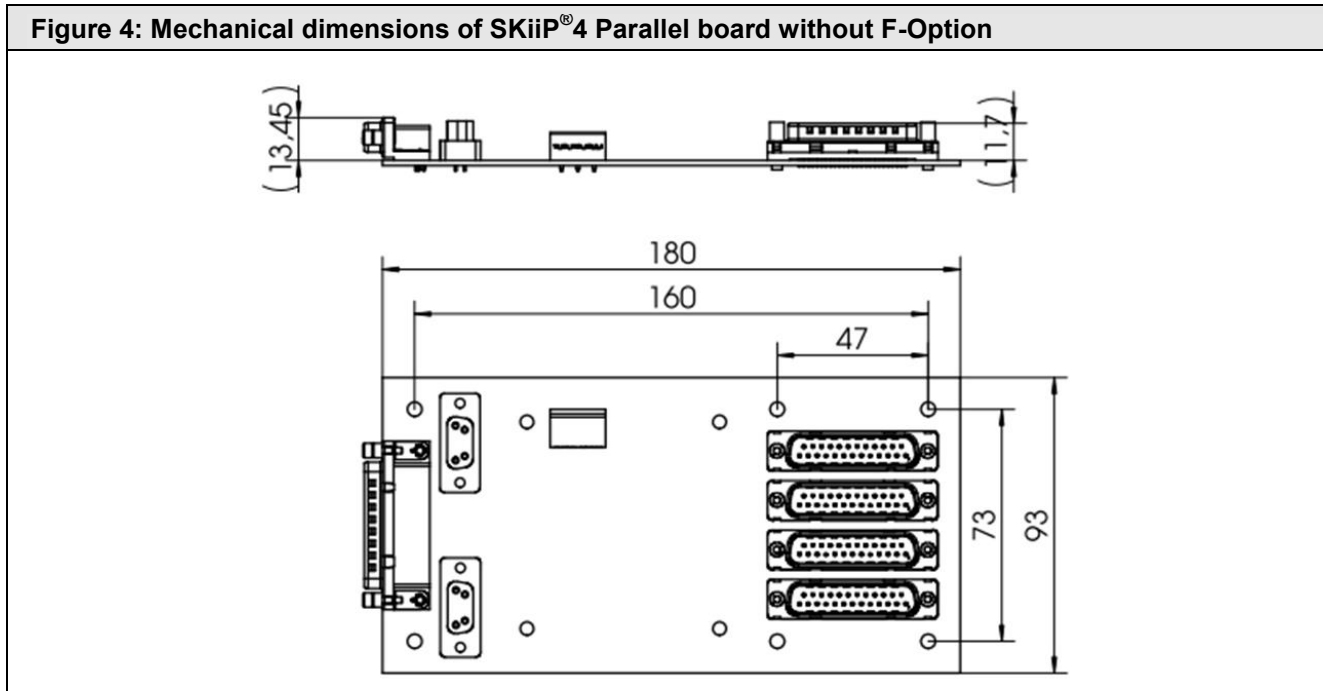
**Figure 3: Block diagram of main functions of SKiiP<sup>®</sup>4 Parallel board on example of 4-fold Parallel board not F-option compatible**



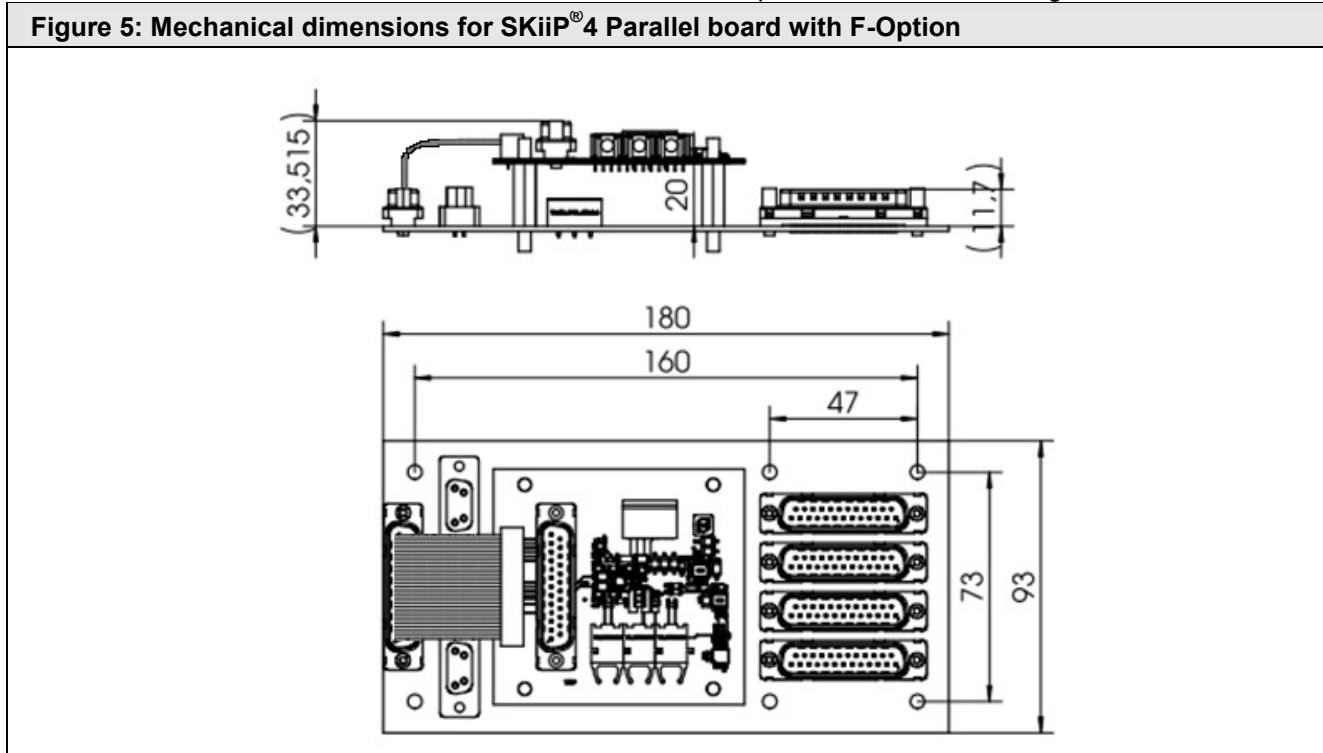
\*Starting with date code 1635

## 5 Dimensions

The mechanical dimensions for SKiiP<sup>®</sup> 4 Parallel board without F-Option are shown in the Figure 4.



The mechanical dimensions for SKiiP<sup>®</sup> 4 Parallel board with F-Option are shown in the Figure 5.



**Please note:** Diameter of all holes is 4.3 mm. The length of cable connection between Parallel board and SKiiP<sup>®</sup> 4 subsystems should not exceed 2m. The strain relief should be done after max. 0,3-0,5m.

## 6 Pin Description

The Parallel board is equipped with the SEMIKRON “SKiFace Standard” interface which has a 25-pin D-Sub connector. Please refer to the Technical Explanation SKiiP<sup>®</sup>4 for more detailed information.

### 6.1 Pin assignment of controller connector X1 and SKiiP<sup>®</sup>4 Connectors (X3, X4, X5, X6)

**Please note:** The plastic cover of D-Sub connector should be removed shortly before the start of operation (ESD-Handling)

Please refer to SKiiP4 Technical Explanation, Chapter “Gate driver interface SkiFace” for further information and pin out of connectors X1,X3,X4,X5,X6.

**Please note:** Supplying of F-Option Board by controller connector X1 (pins 1,2,3) is only available for Parallel board setup compatible to F-Option

### 6.2 Pin array CAN-Bus Connector X7 (CAN out)/X8 (CAN in)

Table 1: CAN-Bus connector pin assignment			
Pin	Signal name	Function	Specification
01,04, 06,08,09	-	reserved	
02	AUX_B	CAN Interface INPUT/OUTPUT LOW	
03	GND	Internally connected to PWR_GND	
05	SHLD_GND	GND	Internally capacitive connected to PWR_GND
07	AUX_A	CAN Interface INPUT/OUTPUT HIGH	

## 7 External Power Supply

The supply voltage for SKiiP<sup>®</sup>4 Parallel board and for the all connected SKiiP<sup>®</sup>4 subsystems must be provided over power supply connector X2.

The pin assignment of external power supply connector X2 is shown in the Table 2

Table 2: Power supply connector X2 pin assignment			
Pin	Signal name	Function	Specification
1	SHLD_GND	Ground	Internally capacitive connected to PWR_GND
2	GND	Ground	
3	+24V	Supply voltage input for parallel board and SKiiP “A” to “D”	See Power Supply

**Please note:** In case of usage Parallel board setup with F-option the power supply for SKiiP<sup>®</sup>4 F-Option Board should be provided over power supply connector X2 on the SKiiP<sup>®</sup>4 Parallel board.

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

<b>Table 3: Requirements of the external power supply</b>	
Power supply	Supply voltage should be +24V (+/- 20%). The minimal possible supply voltage is therefore 19,2 V, which should be measured at SKiiP <sup>®</sup> 4 input, not at Parallel board (voltage drop on connection cable)
Maximum rise time of 24V	< 2s
Rated current	Number of connected SKiiP system x 1.5 times of the maximum SKiiP driver input current
Minimum peak current of auxiliary supply	Number of connected SKiiP <sup>®</sup> 4 subsystem x 2 times of the maximum SKiiP driver input current. At least 6A for 4 connected SKiiP <sup>®</sup> 4 subsystems (full load)

For further information please refer to the Technical Explanation SKiiP<sup>®</sup>4.

**Please note:** Power supply cable should be twisted or screened to enhance the EMC robustness.

## 8 Digital Input/Output Signals

### 8.1 Switching Signal Inputs

Please refer to SKiiP<sup>®</sup>4 Technical Explanation, Chapter “Switching Signal Inputs” for further information.

### 8.2 HALT Logic Signal

Please refer to SKiiP<sup>®</sup>4 Technical Explanation, Chapter “Halt Logic Signal” for further information.

### 8.3 GPIO Signal

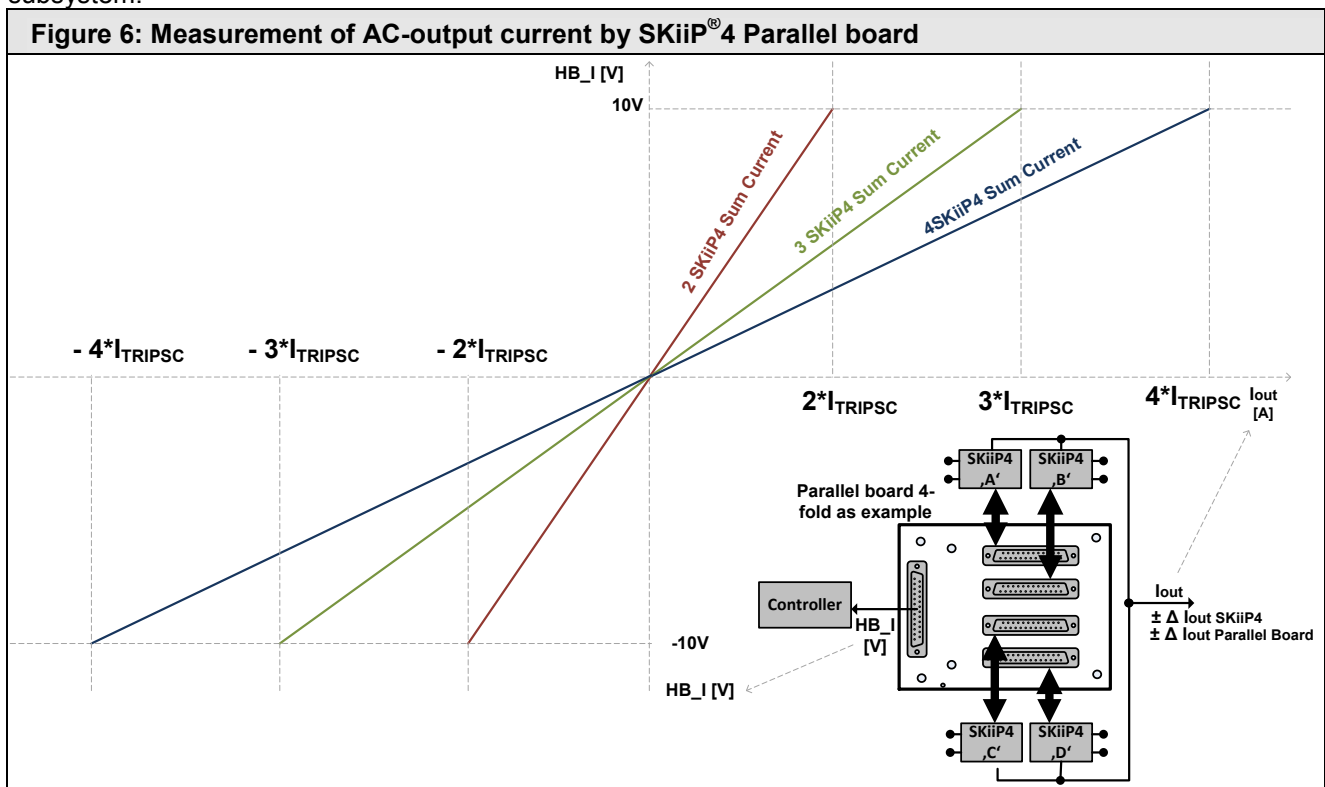
Please refer to SKiiP<sup>®</sup>4 Technical Explanation, Chapter “CMN\_GPIO Signal” for further information.

### 9 Analogue Output Signals

Please refer to SKiiP<sup>®</sup>4 Technical Explanation, Chapter “Analogue Output Signal” for further information about connecting of the analogue output signals to the controller board.

#### 9.1 Measurement of AC-output current

The Parallel board sums all the output current values from the connected SKiiP<sup>®</sup>4 subsystems. The value of sum current must be divided by the number of connected SKiiP<sup>®</sup>4 subsystems to get the current value per SKiiP<sup>®</sup>4 (See Figure 6). The measured current is normalized to a corresponding voltage at the D-Sub Interface of the Parallel board. Please see the data sheet SKiiP<sup>®</sup>4, page 2 for the  $I_{TRIPSC}$  value for corresponding SKiiP<sup>®</sup>4 subsystem.



To calculate the current value for connected SKiiP<sup>®</sup>4 subsystems see Table 4. The values given in the Table 4 are related only to the SKiiP<sup>®</sup>4 Parallel board. For SKiiP<sup>®</sup>4 current measurement parameters please refer to the SKiiP<sup>®</sup>4 Technical Explanation, Chapter “AC-Current sensor”.

**Table 4: Signal characteristics of current measurement**

Signal Characteristics	Value
Output signal	HB_I / HB_I_GND at connector X1
Max. output current $I_{I-out}$	5mA
Output voltage range $V_{I-Out}$	-10V to +10V (normalized, independent from number of SKiiP4 subsystems)
Current value per connected SKiiP <sup>®</sup> 4 system	Parallel board 2-fold → current value @Parallel board* 0,5 Parallel board 3-fold → current value @Parallel board* 0,33 Parallel board 4-fold → current value @Parallel board* 0,25 See Figure 6
Accuracy of analogue signal, $\Delta Iout$ Parallel board	$\pm 1\%$ <sup>1)</sup>

<sup>1)</sup> Considering the aging drift of precision input resistors the accuracy can maximal increase to  $\pm 1.8\%$  for sum current over full temperature range.

### 9.2 Measurement of DCB temperature

The analogue temperature signals from connected SKiiP<sup>®</sup>4 subsystem are handled to the Parallel board. The Parallel board compares the temperature values measured by each SKiiP<sup>®</sup>4 subsystem and provides the maximal DCB temperature value to the controller. The analogue temperature signal is available on the controller connector with the characteristic given in the Table 5. The values given in the Table 5 are related only to the Parallel board SKiiP<sup>®</sup>4. Please refer to the SKiiP<sup>®</sup>4 Technical Explanation, Chapter “Integrated DCB-temperature sensor” for further information.

Table 5: Signal characteristics of temperature measurement	
Parameters $U_{TEMP}$	Specification @ $-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$
Output signal	CMN_TEMP / CMN_TEMP_GND at connector X1
Max. output current $I_{T-out}$	5mA
Output voltage range $V_{T-Out}$	0V to 10V
Analogue temperature signal CMN_TEMP@150°C	10V
Analogue temperature signal CMN_TEMP@30°C	0V
Signal bandwidth (Input to Output)	Max. 50 Hz
Signal accuracy (Input to Output; Over full temp. range)	$\pm 3\%$

### 9.3 Measurement of DC-link voltage

The analogue DC-link voltage signals from connected SKiiP<sup>®</sup>4 subsystem are handled to the Parallel board. The Parallel board compares the DC-Link voltage values measured by each SKiiP<sup>®</sup>4 subsystem and provides the maximal DC-Link voltage value to the controller. The analogue signal for the  $U_{DCL}$  is available on the D-Sub interface to controller with the characteristics given in the Table 6. The values given in the Table 6 are related only to the Parallel board SKiiP<sup>®</sup>4. Please refer to the SKiiP<sup>®</sup>4 Technical Explanation, Chapter “DC-link voltage sensing” for further information.

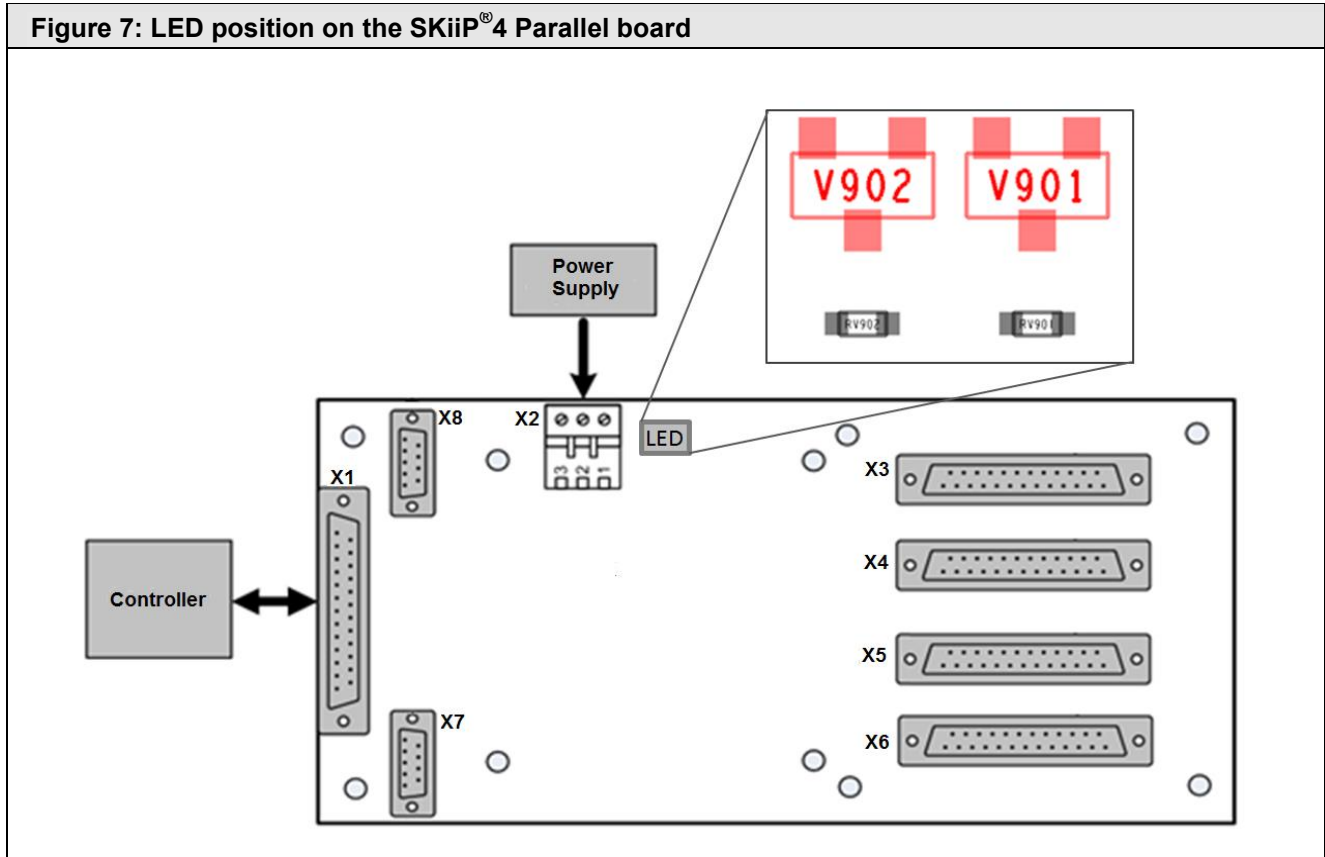
Table 6: Signal characteristics of DC-Link measurement	
Parameters $U_{TEMP}$	Specification @ $-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$
Output signal	CMN_DCL / CMN_DCL_GND at connector X1
Max. output current $I_{T-out}$	5mA
Output voltage range $V_{T-Out}$	0V to 10V
Analogue DC-link voltage signal CMN_DCL @ 900V	9V for 1200V SKiiP <sup>®</sup> 4 System and 6,5V for 1700V SKiiP <sup>®</sup> 4 System
Analogue DC-link voltage signal CMN_DCL @ 1200V	9V for 1700V SKiiP <sup>®</sup> 4 System
Signal bandwidth (Input to Output)	Max. 4 kHz

Signal accuracy (Input to Output; Over full temp. range)	Typ. $\pm 1\%^2$
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<sup>2)</sup> Considering the aging drift of precision input resistors the accuracy can maximal increase to  $\pm 1.6\%$  for temperature signal over full temperature range.

### 10 Error indication with LED

Two LED are placed on the Parallel board for error indication. The location of the LEDs is shown in the Figure 7.



The description of the error indication is done in the Table 7.

**Table 7: LED states and meanings**

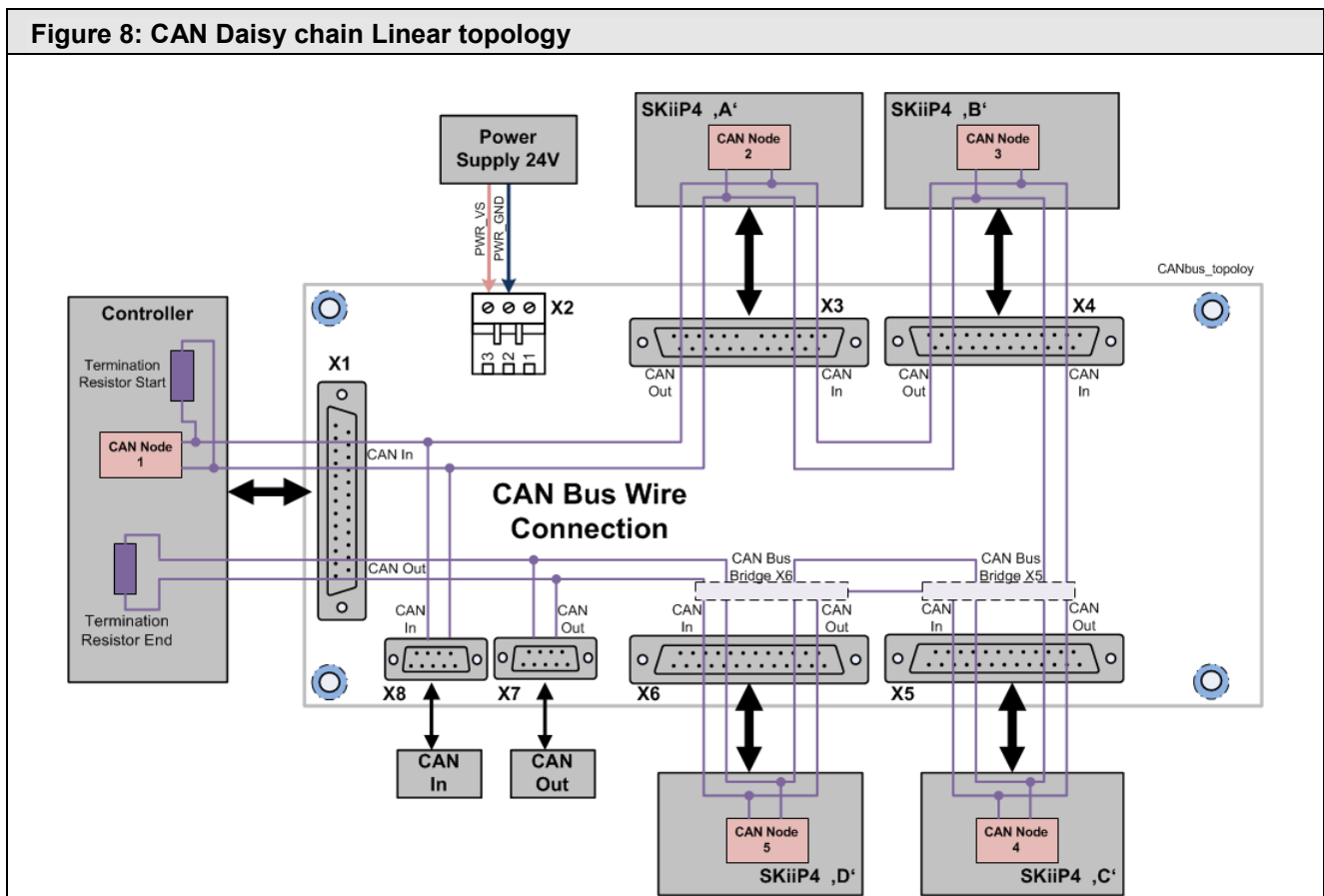
Operating mode	LED lights	
	V901	V902
No error	green	off
Error	green	green

**Please note:** Only above listed states are possible in regular operation mode. If some other state is present, there is no supply voltage for the board or the LED/LEDs are out of functioning.

### 11 CAN-Interface

The SKiiP<sup>®</sup>4 IPM is equipped with a 3,3V CAN transceiver type SN74LVC2T45QD from TI.  
For a detailed description of the SKiiP<sup>®</sup>4 CAN interface please refer to the documents

- CANopen Object Dictionary
- CANopen Interface Documentation

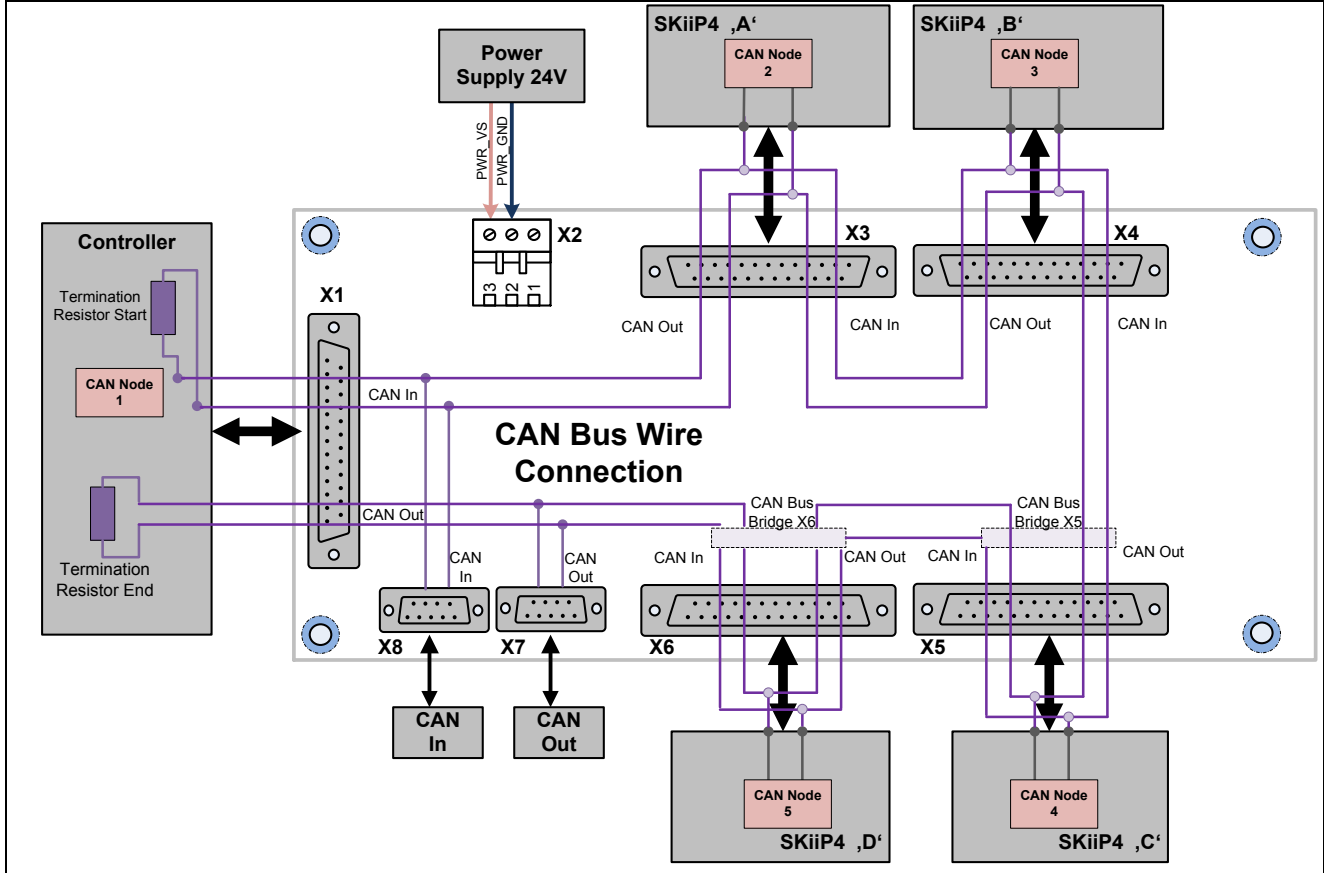


Characteristics of the CAN bus wire connection:

- CAN Daisy chain Linear topology with minimal branch length
- CAN bus can be driven through X1 connector or the two 9-pin D-Sub connectors X8/X7 (a mixture is possible as well)

**Please note:** The above described CAN-Interface topology is only compatible with SKiiP<sup>®</sup>4 subsystems with date code >1309. In case of date code on the SKiiP<sup>®</sup>4 ealier than 1309 the usage of CAN-Interface as in the Figure 8 is not possible. In that case the connection as in Figure 9.

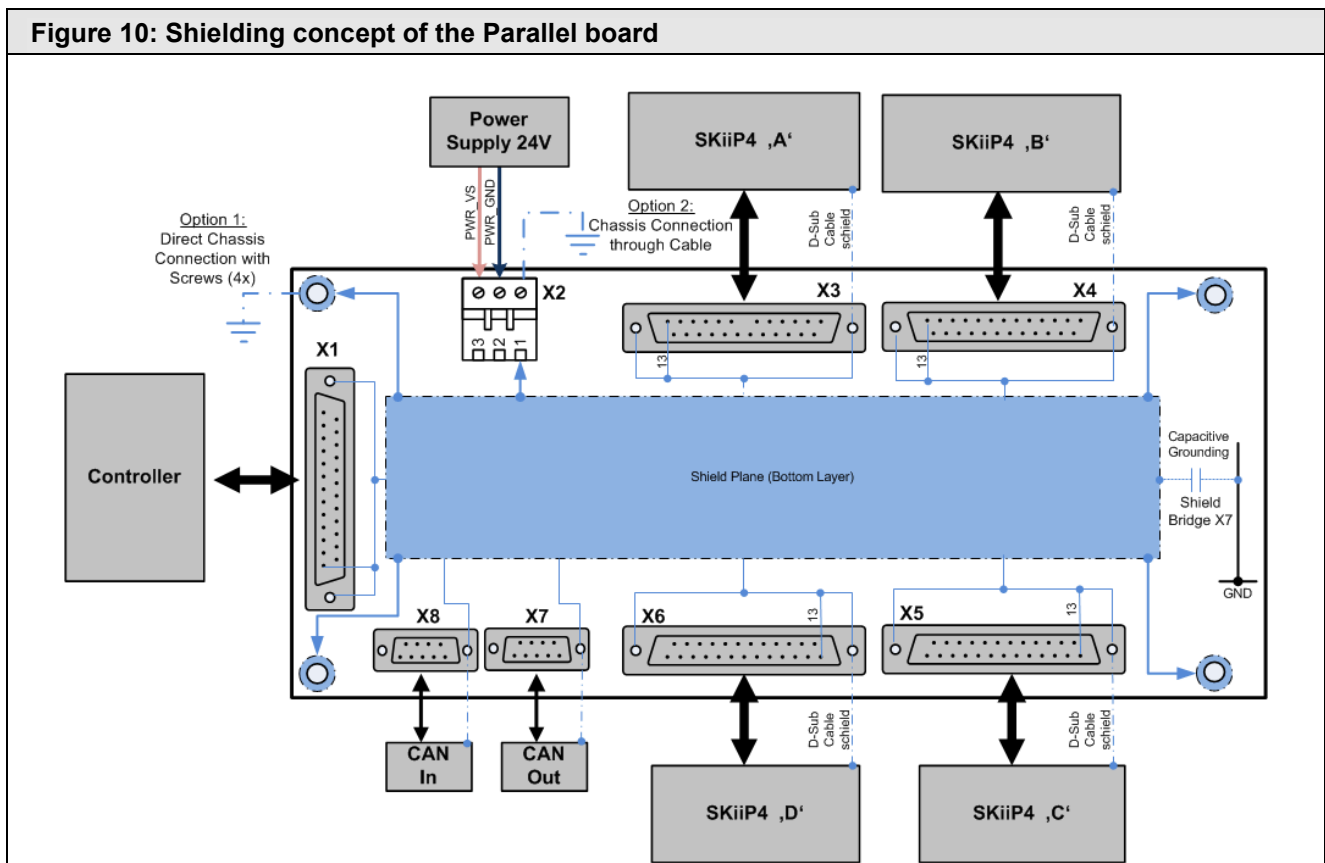
**Figure 9: CAN Daisy chain Linear Topology for SKiiP<sup>®</sup>4 version (date code <1309)**



### 12 Ground connection

SKiiP<sup>®</sup>4 Parallel board has the same ground connection as SKiiP<sup>®</sup>4. Please refer to SKiiP<sup>®</sup>4 Technical Explanation, Chapter “Ground connection” for further information.

### 13 Shielding Concept



The shield from all D-Sub connectors (X1/X3/X4/X5/X6/X7/X8) shall be centrally merged with the shield plane within the board. A capacitive connection exists between Shield and PWR\_GND (Shield Bridge X7).

The shield level should be connected to the Chassis/PE in the following way:

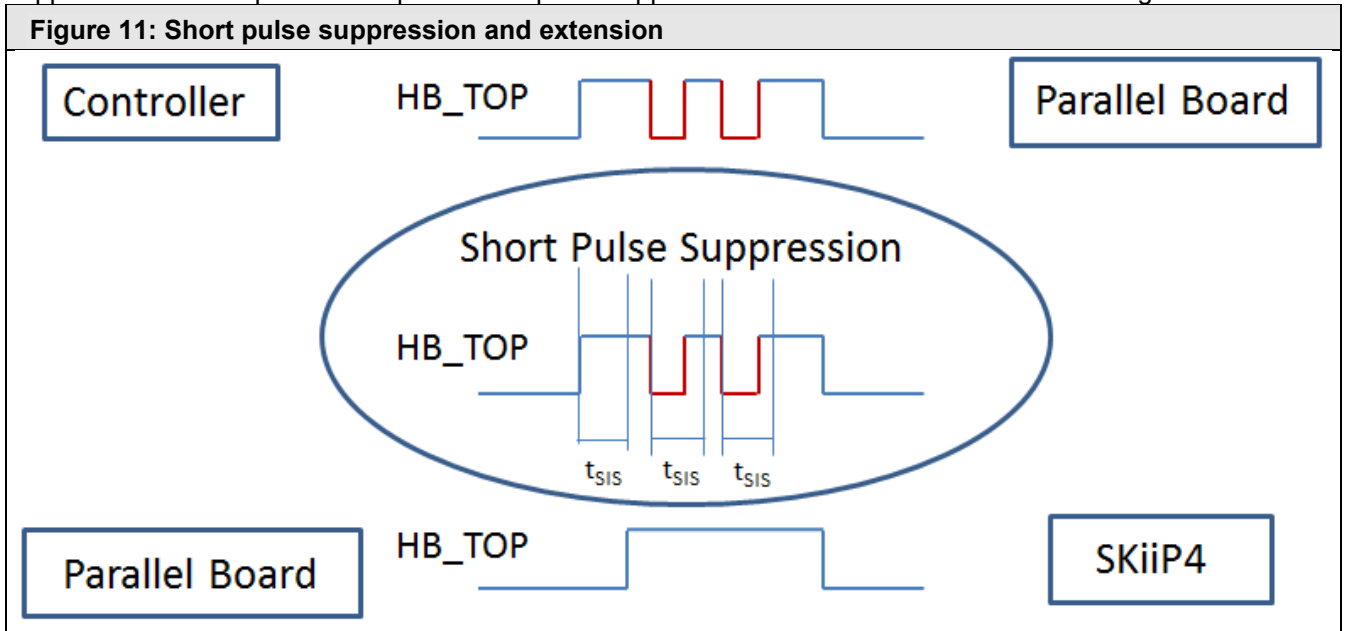
connecting the SKiiP<sup>®</sup>4 Parallel board to the rear panel metal frame with 4 metal screws.

Electrical connection is done through metal screws.

**Please note:** The shield connection should be performed with metal screws with head diameter less than 7,7 mm.

## 14 Short pulse suppression and extension

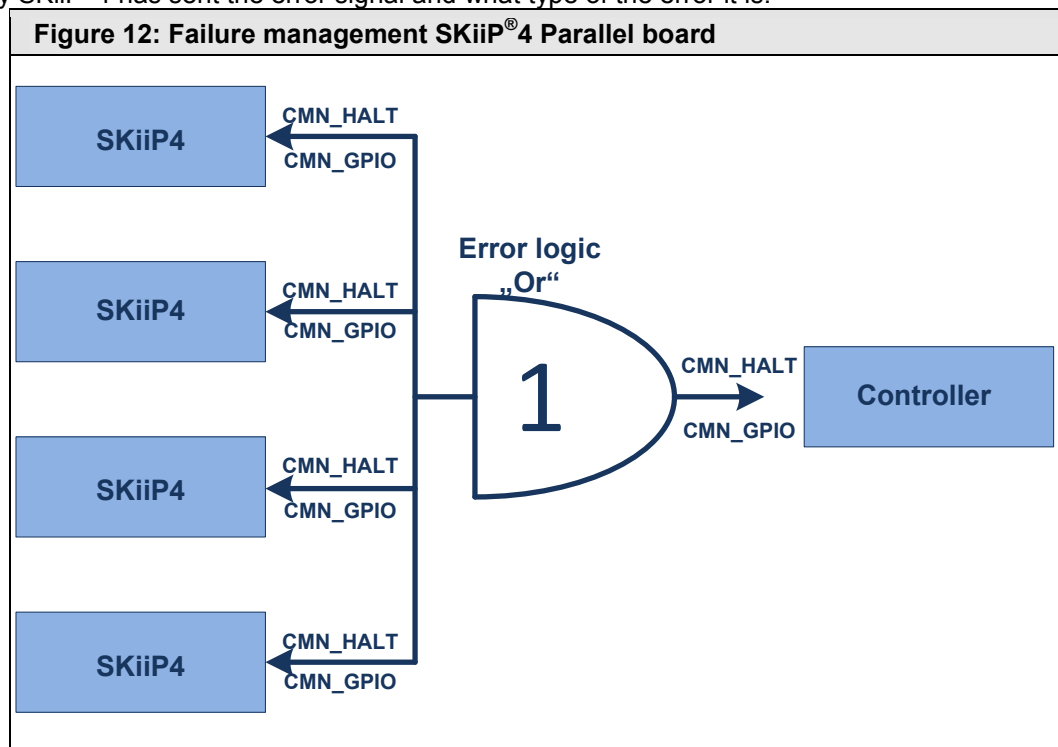
The short pulse suppression time is defined as  $t_{SIS}$  in the SKiiP<sup>®</sup>4 Parallel board data sheet. The function suppresses short turn-on and off-pulses at the pins HB\_TOP and HB\_BOT of the SKiFace interface. In this way the IGBTs are protected against spurious noise which can occur due to bursts on the signal lines. Pulses shorter than  $t_{SIS}$  are suppressed. If the pulse is longer than  $t_{SIS}$  but shorter than  $1\mu s$ , it will be automatically extended to  $1\mu s$  by the Parallel board. Otherwise it is possible, that the rest of pulse after short pulse suppression of parallel board will be faulty determined as short pulse by the SKiiP<sup>®</sup>4 and suppressed. The simplified example of short pulse suppression and extension is shown in the Figure 11.



Two simultaneously occurred signals with the same level will be processed as follows: the output switching signal that was as last one in LOW state will be set to HIGH state and the other one will be set to LOW state.

### 15 Failure Management

The Parallel board transfers the error signals from all connected SKiiP<sup>®</sup>4 subsystems to the controller and vice versa (see Figure 12). If controller becomes an error signal it is always possible to see via CAN-Interface which particularly SKiiP<sup>®</sup>4 has sent the error signal and what type of the error it is.



In addition to this Parallel board has two own failure management features:

- Monitoring of internally generated voltages. For normal functioning of internal blocks of Parallel boards different power supply levels are necessary. All internally generated power supplies are monitored to avoid under- or overvoltage and to guarantee the correct functioning of parallel board.
- Detection of cable break over GPIO1 Error signal.

If under- or overvoltage of internally generated voltages occurs, the Parallel Board will set the HALT signal into LOW state (not ready to operate) for the the error time + at least "error reset time ( $t_{pRESET}$ ) of SKiiP<sup>®</sup>4". The connected SKiiP4 subsystems will be switched off. During  $t_{pRESET}$  the drivers of connected SKiiP<sup>®</sup>4 subsystems will check if the TOP/BOT input signals are set to low. If this is the case and no error is still present the drivers will release the HALT signal. If the input signals have not been switched to LOW state the drivers will pull the HALT signal to low (dominate) as long as the input signals are not low. So the input signals should be set to low within the error reset time and not be activated before the HALT signal is in high state.

If cable break is detected, the Parallel Board will set the GPIO signal into HIGH state (error present). The connected SKiiP<sup>®</sup>4 subsystems will not be switched off. The customer should take care for the switching off the SKiiP<sup>®</sup>4 systems.

### 16 Paralleling of SKiiP systems

Please refer to SKiiP<sup>®</sup> 4 Technical Explanation, Chapter "Paralleling of SKiiP" for further information.

### 17 Mounting of F-Option

The following plastic standoff adapters are designed for mounting the F-Option on SKiiP<sup>®</sup> 4 Parallel board.

Plastic standoff adapters: round, length 20 mm, screw thread M4,  
material Polyamid 6,6, diameter 8 mm  
Plastic round head screw: M 4 x 8, DIN 85/ISO 1580, PA 6.6, trench;  
Plastic screw nut: M4 metric;

Example: 05.44.320  
Example: 01.45.436  
Example: 02.05.049

### 18 Tests for qualification

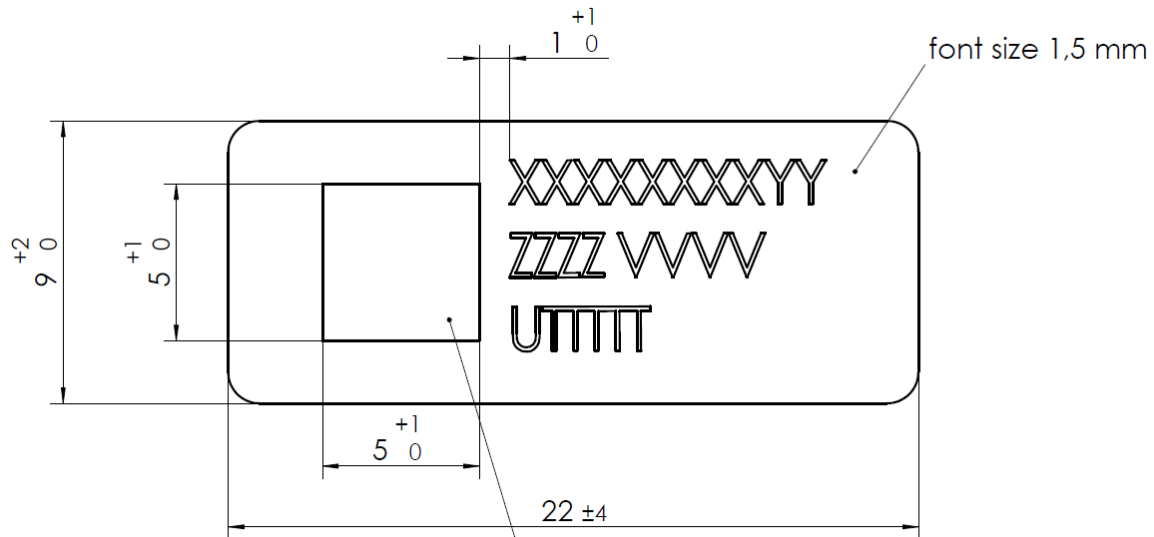
Table 8: SKiiP <sup>®</sup> 4 Parallel Board Tests for qualification			
No	Test	Test Conditions	Standard
01	High Temperature Operation test	1000h, 85°C	IEC 60747-9
03	High Humidity Operation test	1000h, 85°C, 85% RH, V <sub>Sop</sub>	IEC 60068 Part 2-67
04	High Temperature Storage	1000h, T <sub>a</sub> = +85°C	IEC 60068 Part 2-2
05	Low Temperature Storage	1000h, T <sub>a</sub> = -40°C	IEC 60068 Part 2-1
06	Thermal Cycling Storage	1000 cycles, -40°C/ +85°C	IEC 60068 Part 2-14
07	Thermal Cycling Operation	1000 cycles, -40°C/ +85°C	IEC 60068 Part 2-14
08	Vibration	Sinusoidal Sweep, 20-500Hz, 5g, x, y, z – axis, 2h/ axis	IEC 60068 Part 2-6
09	Shock	Halfsinusoidal Pulse, 30g, 10ms, +/- x, +/- y, +/- z direction, 1000 times per direction	IEC 60068 Part 2-27

### 19 Electromagnetic compatibility (EMC)

Table 9: SKiiP <sup>®</sup> 4 Parallel Board Electromagnetic compatibility		
Immunity test	Conditions	Test level
Fast transients (Burst) (61000-4-4)	On driver board interfaces	4kV / 5kHz
Radio Frequency Fields (61000-4-3)	Polarisation: vertical + horizontal Frequency: 80 MHz - 1000 MHz Modulation: 80% AM, 1kHz Far field, homogeneous	20V/m
RF Conducted Disturbance (61000-4-6)	Frequency: 150 kHz - 80 MHz Modulation: 80 % AM, 1kHz	Voltage: 20V EMF
Magnet field (61000-4-8)	Far field, homogeneous	150A/m
Electrostatic discharge (ESD) EN 61000-4-2	Contact discharge Air discharge	6kV 8kV

20 Logistics

Figure 13: Part Marking Information

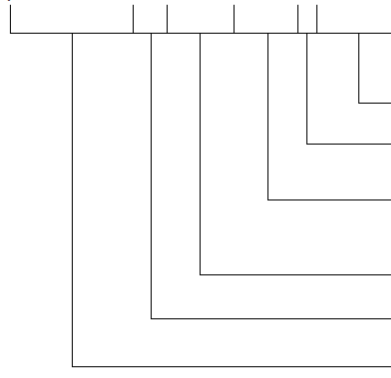


Data-Matrix area:  
max. 34 signs  
cell dimension 0,254 - 0,3 mm  
scan distance: 60-100mm  
scan angle max 30 degrees of perpendicular angle

lettering Data-Matrix area:

XXXXXXXXXXYYZZZZVVVVUTTTT  
(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

## 21 Provisions and handling after use

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

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### **HISTORY**

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