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- L5064102
- L5064103

with date code(JJWW) ≥ 1245.

Technical Explanation SKiiP®3 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.

Table of content:

1 Related documents

- Data sheet Parallel board SKiiP®3
- Technical Explanation SKiiP®3 Rev.2
- Data sheet SKiiP®3
- Technical Explanation F-Option Board SKiiP®3
- Data sheet F-Option Board SKiiP®3

2 Application and handling instructions

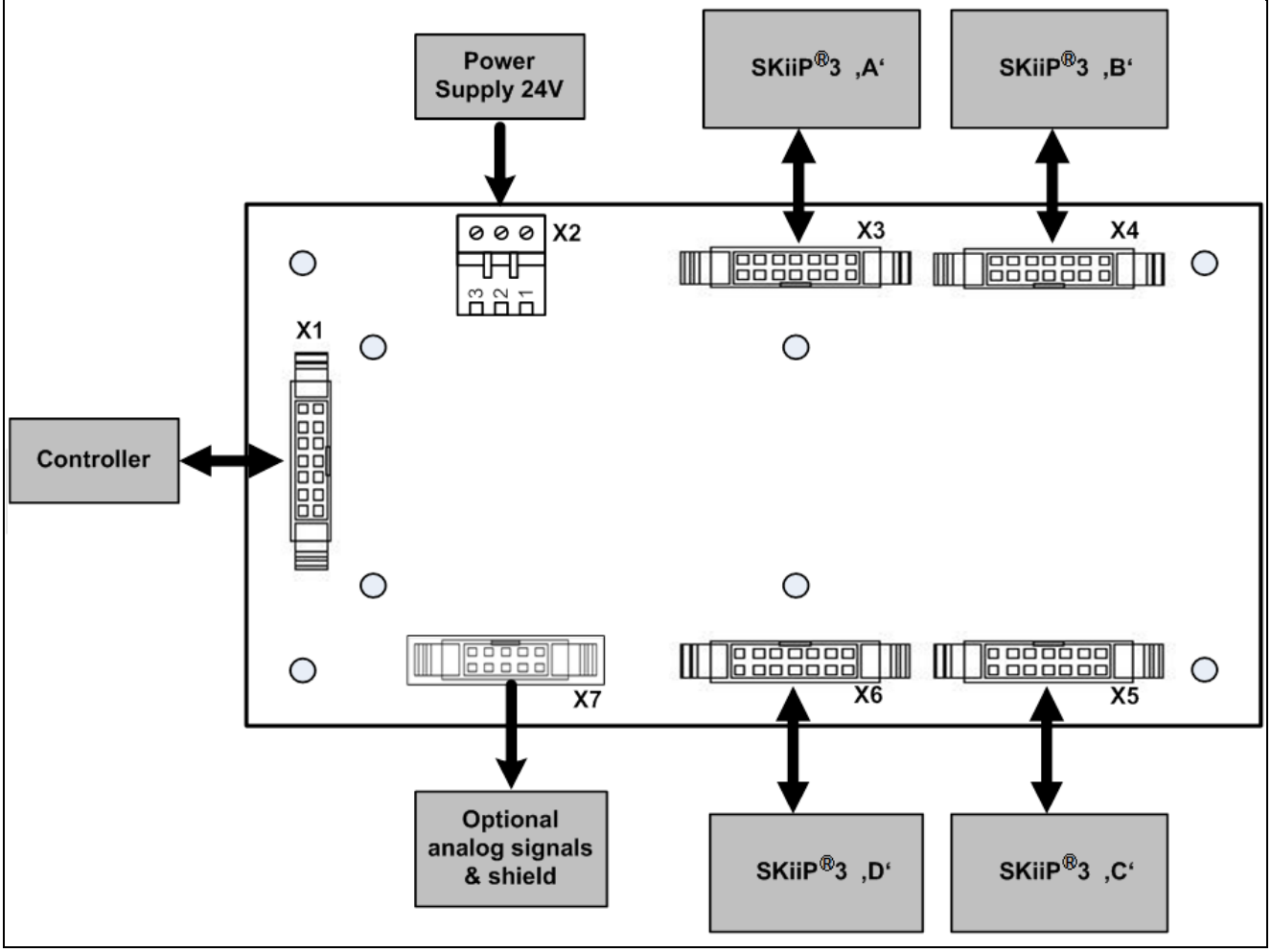
- Please provide static discharge protection during handling. As long as the board is not completely assembled, the input terminals have to be short-circuited. Persons working with devices have to wear a grounded bracelet. Any synthetic floor coverings must not be statically chargeable. Even during transportation 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 over-voltage. Voltages higher than V_S +0,3V or below -0,3V may destroy these inputs. Therefore, control signal over-voltages exceeding the above values have to be avoided.

3 General description

3.1 Overview

SKiiP®3 subsystems are connected in parallel to achieve higher output current. The SKiiP®3 Parallel board is designed for connecting up to four SKiiP®3 subsystems to one controller. The example of SKiiP®3 Parallel board application is shown in the Figure 1. The switching signals from controller are routed to all paralleled devices. Analogue signal measurements and error siganls from the paralleled devices are converted and transferred to the controller.

Figure 1: An example of SKiiP®3 Parallel board application



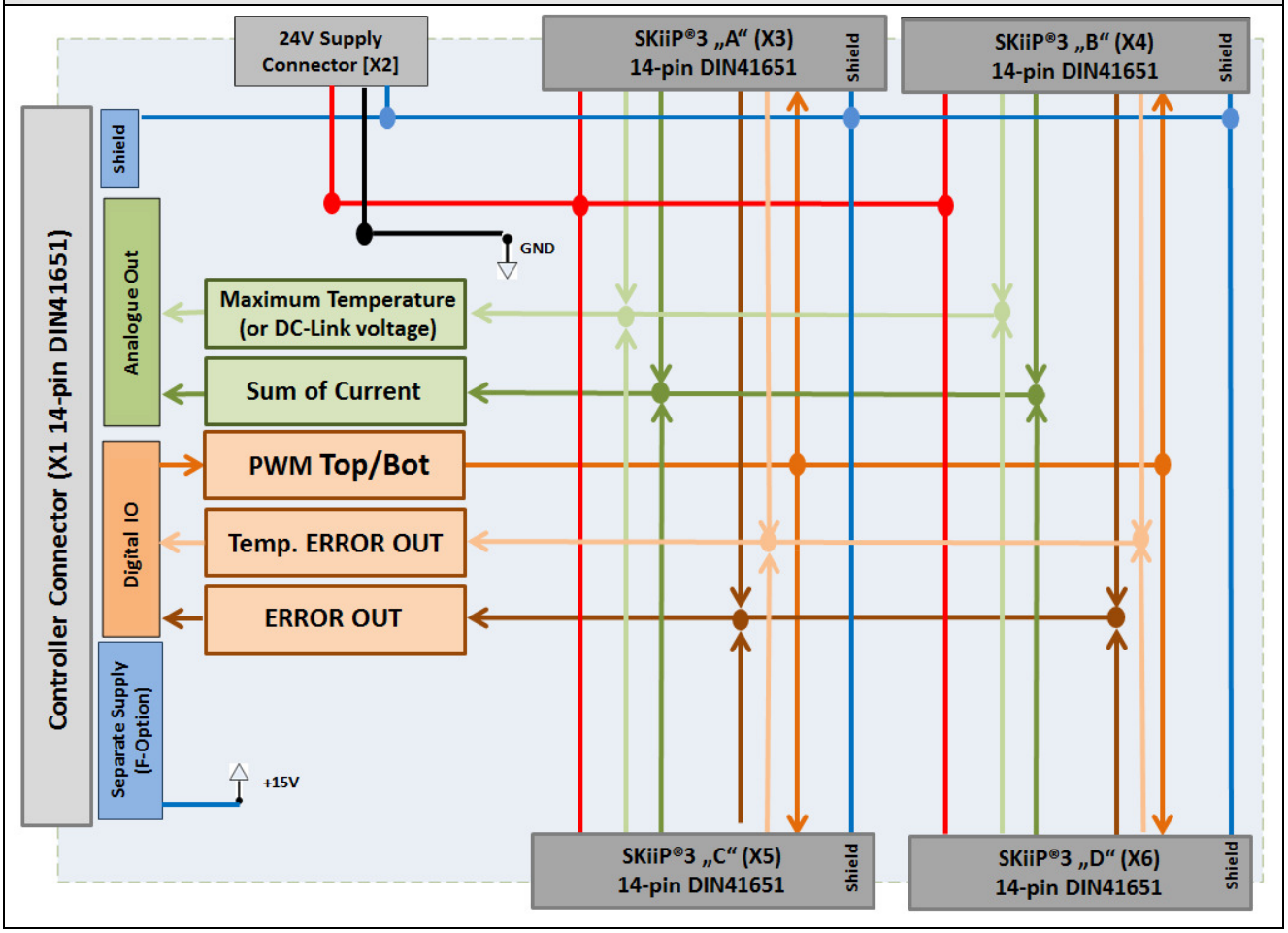
For an EMI-safe transmission of the switching- and error-signals, there is the possibility to mount an optional fiber-adapter F-Option board SKiiP®3 on top of the SKiiP®3 Parallel board. No mechanical housing is required since the board is directly mounted on a metal frame inside the cabinet.
All different SKiiP®3 Parallel board product variants are based on one common board-layout but do have different number of connected SKiiP®3 subsystems:

- **Type 1:** Board setup for paralleling of **two** SKiiP®3 GB systems 1200V/1700V with and without F-Option (using connector X3/X4 & **vertical** connector X1)
- **Type 2:** Board setup for paralleling of **three** SKiiP®3 GB. systems 1200V/1700V with and without F-Option (using connector X3/X4/X5 & **vertical** connector X1)
- **Type 3:** Board setup for paralleling of **four** SKiiP®3 GB systems 1200V/1700V with and without F-Option (using connector X3/X4/X5/X6 & **vertical** connector X1)

The pollution degree class 2 and IP00 shall be considered for the SKiiP®3 Parallel board.

4 Block diagram

Figure 2: Block diagram of main functions of SKiiP®3 Parallel board



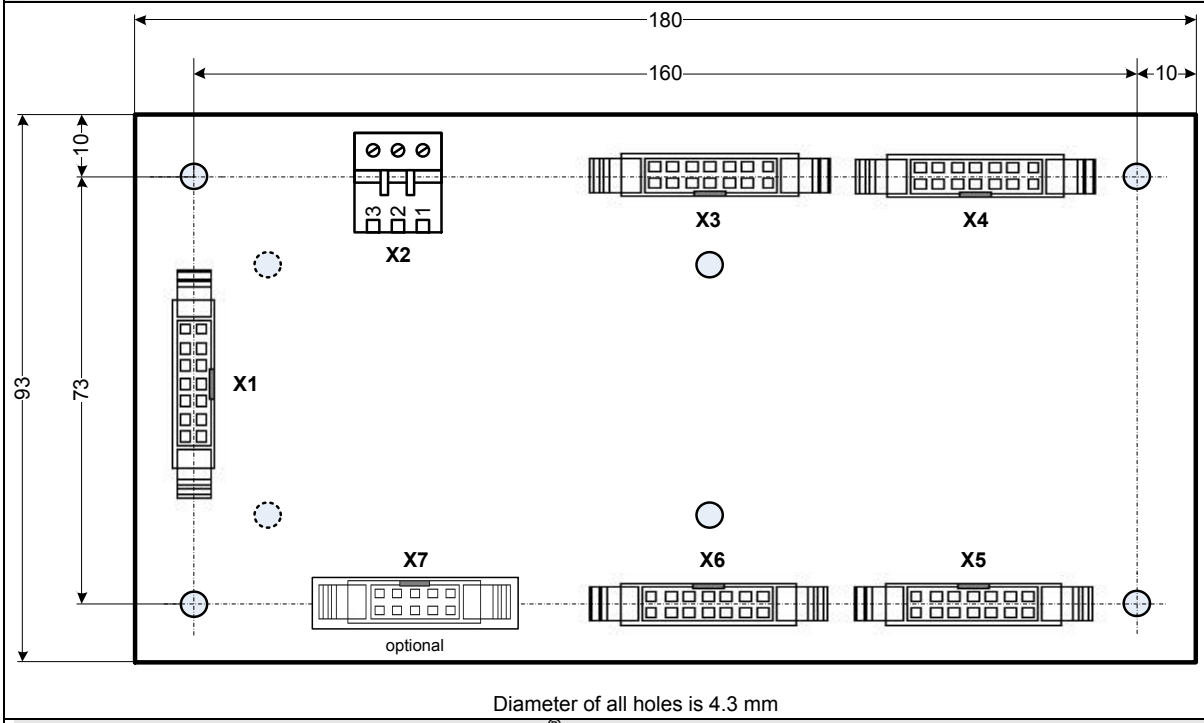
The main functions of the SKiiP®3 Parallel board are shown in the Figure 2. They are:

- 24V routing from supply connector X2 to all four SKiiP®3 DIN41651-connectors X3/X4/X5/X6
- Generation of +15V for F-Option-Board. It will be supplied by the controller connector X1 (+15V)
- Monitoring the +15V; -15V; in case of failure the ERROR signal will be activated.
- Providing the maximum temperature value or maximum DC-link voltage of all connected SKiiP®3 subsystems (Analogue Out, Pin 12 / connector X1)
- Providing the sum of currents of all connected SKiiP®3 subsystems (Analogue Out, Pin 14 / connector X1)
- Routing the TOP/BOT switching signals from the controller (Digital IO, Pin 4 and Pin 2 / connector X1) to all four SKiiP®3 connectors X3/X4/X5/X6 (incl. Short-Pulse-Suppression, TOP/BOT-Interlock and min. Pulse-Time)
- Linking the error and temperature error signals from the connected SKiiP®3 subsystems to the corresponding error signal (Digital IO, Pin 3 and Pin 5 / connector X1)
- Providing grounding option via metal screws or over the supply connector X2 for the shield of all four SKiiP®3 connectors X3/X4/X5/X6.

5 Dimensions

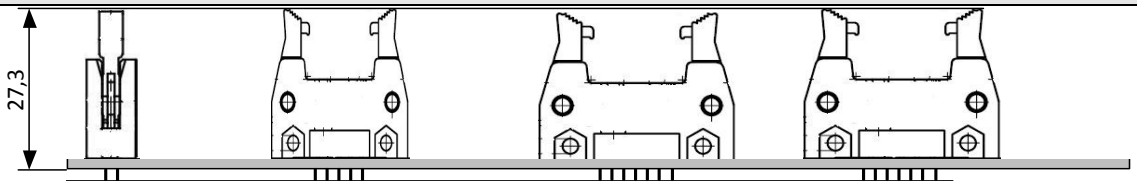
The mechanical dimensions for SKiiP®3 Parallel board without F-Option are shown in the Figure 3 and Figure 4. The optional connector X7 is schown on the both drawings.

Figure 3: Mechanical dimensions of SKiiP®3 Parallel board without F-Option (Top view)



Diameter of all holes is 4.3 mm

Figure 4: Mechanical dimensions of SKiiP®3 Parallel board without F-Option (side view)



The mechanical dimensions for SKiiP®3 Parallel board with F-Option (shown in the Figure 5) are the same as without F-Option with exeption of height, which is given in the Figure 6. The optional connector X7 is schown on the both drawings.

Figure 5: Mechanical dimensions for SKiiP®3 Parallel board with F-Option (Top view)

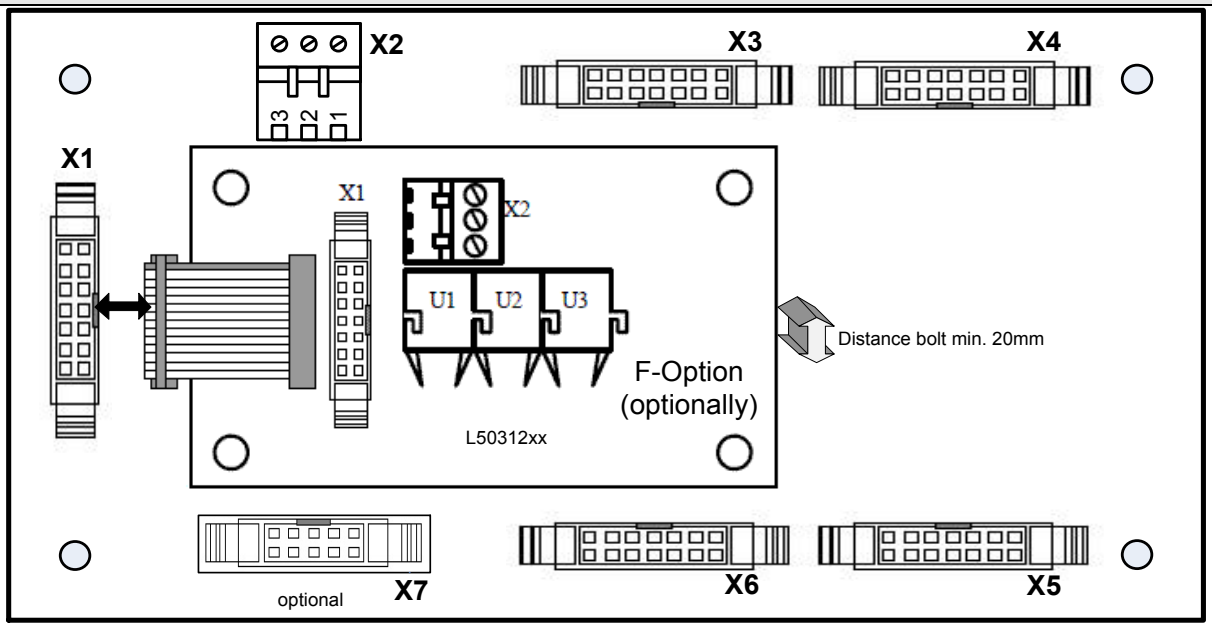
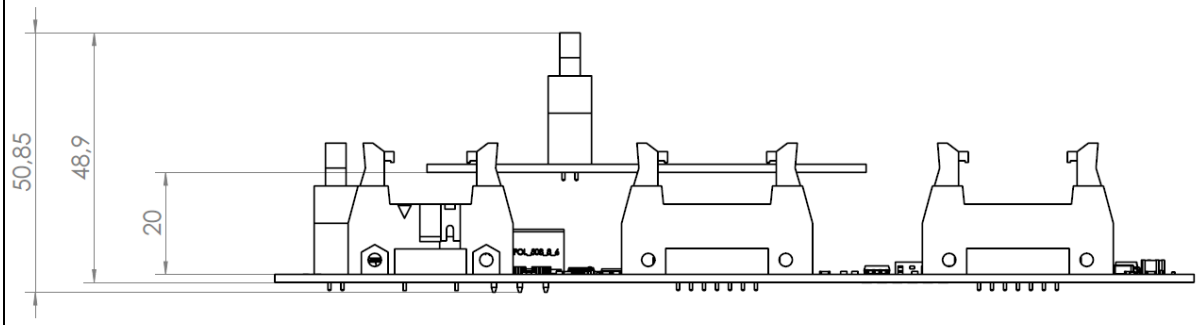


Figure 6: Mechanical dimensions for SKiiP®3 Parallel board with F-Option (Side view)



Please note: Diameter of all holes is 4.3 mm. The length of cable connection between SKiiP®3 Parallel board and SKiiP®3 subsystems should not exceed 2m. Shielded cables should be used.

6 Pin Description

6.1 Pin assignment of Controller Connector X1

The Parallel board is equipped with a 14-pin DIN connector. Please refer to the Technical Explanation SKiiP®3 Rev.2 for more detailed information.

Figure 7: PCB Connector for the controller

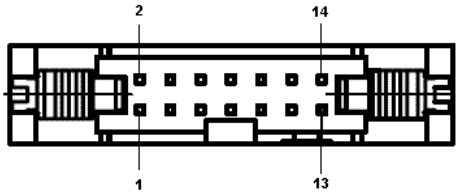


Table 1: Controller connector X1 pin assignment

Pin	Signal name	Function	Specification
1	Shield	Shielding	• For shielded cable
2	BOT IN	PWM signal input for low side IGBTs	• Input • +15V/0V-Logic • 10kΩ impedance
3	ERROR OUT	Common error status signal output	• Open collector output • LOW = no error • Max. 30V/15mA
4	TOP IN	PWM signal input for high side IGBTs	• Input • +15V/0V-Logic • 10kΩ impedance
5	Temp. ERROR OUT	Common over-temperature error signal output	• Open collector output • LOW = no error • Max. 30V/15mA
6	N. C.	Not used	
7	N. C.	Not used	
8	+15V	Supply voltage output for optional level shifter or F-Option	• +15V ±4% • Max. output current: 100mA
9			
10	GND	Power supply ground	
11			
12	TEMP_ANA	Temperature measurement analogue signal output (maximum SKiiP temperature)	• Output voltage range: 0…+10V • Max. output current: 5mA
13	GND_ANA	Ground for analogue signals	
14	I_ANA	Current measurement analogue signal output (sum of AC-currents)	• Output voltage range: -10V…+10V • Max. output current: 5mA

6.2 Pin assignment of SKiiP®3 Connectors (X3, X4, X5, X6).

Please refer to the Technical Explanation SKiiP®3 Rev.2 for pin assignment of the connectors X3, X4, X5, X6.

7 Auxiliary Power Supply

Connector X2 is used to supply the parallel board and the connected SKiiP subsystems.
Table 2 shows the 24V Power supply connector pin assignment.

Table 2: 24V Power supply connector pin assignment

Pin	Signal name	Function	Specification
1	Shield	Shielding	• For shielded cable
2	GND	Ground	
3	+24V	Supply voltage input for Parallel board and SKiiP®3 "A" to "D"	• See Table 3

Please note: Use for 24V power supply wire size of 2.5 mm^2 to withstand max. nominal current of 8A. The minimal possible supply voltage on SKiiP®3 Parallel board is therefore 19,2 V, which should be measured at SKiiP®3 Parallel board input, not at controller output (voltage drop on connection cable).

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

Table 3: Requirements of the auxiliary power supply

Power supply	Supply voltage should be +24V (+/- 20%)
Maximum rise time of 24V	50ms
Rated current	1,5 times of the maximum driver input current
Minimum peak current of auxiliary supply	2 times of the maximum driver input current (At least 8A for 4 connected SKiiP®3 subsystems)

For further information please refer to the Technical Explanation SKiiP®3, Rev.2.

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

8 Digital Input/Output Signals

8.1 TOP/BOT switching signals

The main purpose of SKiiP®3 Parallel board is the routing of the TOP/BOT switching signals from controller connector X1 to all four SKiiP®3 connectors X3/X4/X5/X6. The routing includes the following tasks:
- Logic Level detection of TOP/BOT signals;
- Short pulse suppression and extension of TOP/BOT signals (See Chapter 13);
- Generation of Interlock time for all connected SKiiP®3 (See Chapter 11 for detailed information and corresponding data sheet for t_{TD} time value).

The characteristics of switching signal can be found in the Table 4.

Table 4: Digital signal characteristic TOP/BOT input

Signal name	TOP In BOT In
input threshold voltage (High)	12,3V
input threshold voltage (Low)	4,6V

8.2 ERROR OUT Signal

The SKiiP®3 Parallel board combines all ERROR signals of the SKiiP®3 subsystems as well as the internal ±15V-Observer failure signal, to one unidirectional ERROR OUT signal and routes it to the customer's controller. This output is short-circuit proof.
The ERROR signal is active when one of the connected SKiiP systems is in ERROR mode or when the parallel board is in error mode.

The characteristics of switching signal can be found in the Table 5.

Table 5: Digital signal characteristic ERROR and HALT input

Signal name	ERROR OUT
Description	SKiiP®3: Open collector output without internal pull up resistor. No capacitor to GND

8.3 Temperature ERROR OUT Signal

The SKiiP®3 Parallel board combines all Temperature ERROR signals of the SKiiP®3 to one unidirectional Temperature ERROR OUT signal and routes it to the customer's controller. This output is short-circuit proof. Temperature ERROR is active, when one of the connected SKiiP subsystems is in Temperature ERROR mode.

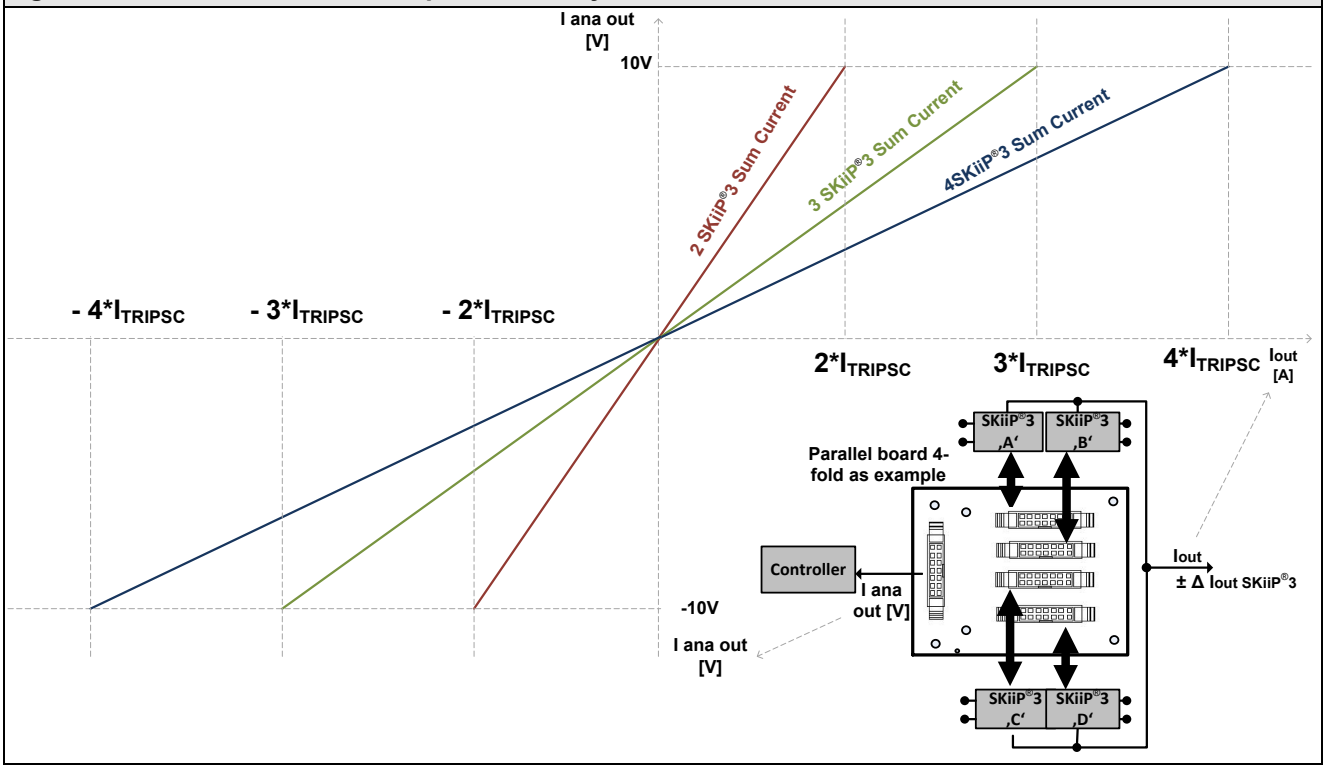
9 Analogue Output Signals

On the user controller board a differential amplifier should be used which is connected to the analogue output and the corresponding ground signals (TEMP_ANA, I_ANA, GND_ANA). This ensures accurate measurement of the analogue signals because there is no voltage drop on the analogue ground wires due to the high input impedance of the differential amplifier. Please refer to the Technical Explanation SKiiP®3, Rev.2 for further information and for recommended electrical circuit.
The analogue signal ground line is not used for supply currents when a differential amplifier is used on the controller side.

9.1 Measurement of output current

The SKiiP®3 Parallel board sums all the output current values from the connected SKiiP®3 subsystems. The value of sum current must be divided by the number of connected SKiiP®3 subsystems to get the current value per SKiiP®3 (See Figure 8). Please see the data sheet SKiiP®3, page 2 for the I_{TRIPSC} value for corresponding SKiiP®3 subsystem.

Figure 8: Measurement of AC-output current by SKiiP®3 Parallel board



The measured current is normalized to a corresponding voltage at the DIN41651 connector of the parallel board. (See Table 6). The values given in the Table 6 are related only to the SKiiP®3 Parallel board. For SKiiP®3 current measurement parameters please refer to the SKiiP®3 Technical Explanation Rev.2 Chapter "AC-Current sensor".

Table 6: Signal characteristics of current measurement

Signal Charakteristics	Value
Output signal	I_ANA / GND_ANA at connector X1
Max. output current $I_{I\text{-}out}$	5mA
Output voltage range $V_{I\text{-}Out}$	-10V to +10V *(normalized, independent from number of SKiiP3 subsystems)*
Amplification ratio	Type 1: 0,5 → signal ratio connected SKiiP®3 (A/V) * 2 Type 2: 0,33 → signal ratio connected SKiiP®3 (A/V) * 3 Type 3: 0,25 → signal ratio connected SKiiP®3 (A/V) * 4
Accuracy of analogue signal	±1%[1)]
Small signal bandwidth	50kHz

[1)] Considering the aging drift of precision input resistors the accuracy can maximal increase to ± 1.8% for "Sum of current" over full temperature range.

9.2 Measurement of SKiiP®3 temperature or DC-link voltage

SKiiP®3 is either configurated for DC-link voltage measurement (U-option) or for temperature measurement. The corresponding analogue signal from connected SKiiP®3 subsystem is handled to the SKiiP®3 Parallel board. The parallel board compares the values measured by each SKiiP®3 subsystem and provides the maximal value to the controller. The analogue signal is available on the DIN connector Pin 12 with the characteristic given in the Table 7. For futher information please refer to the Technical explanation SKiiP®3.

Table 7: Signal characteristics of current measurement

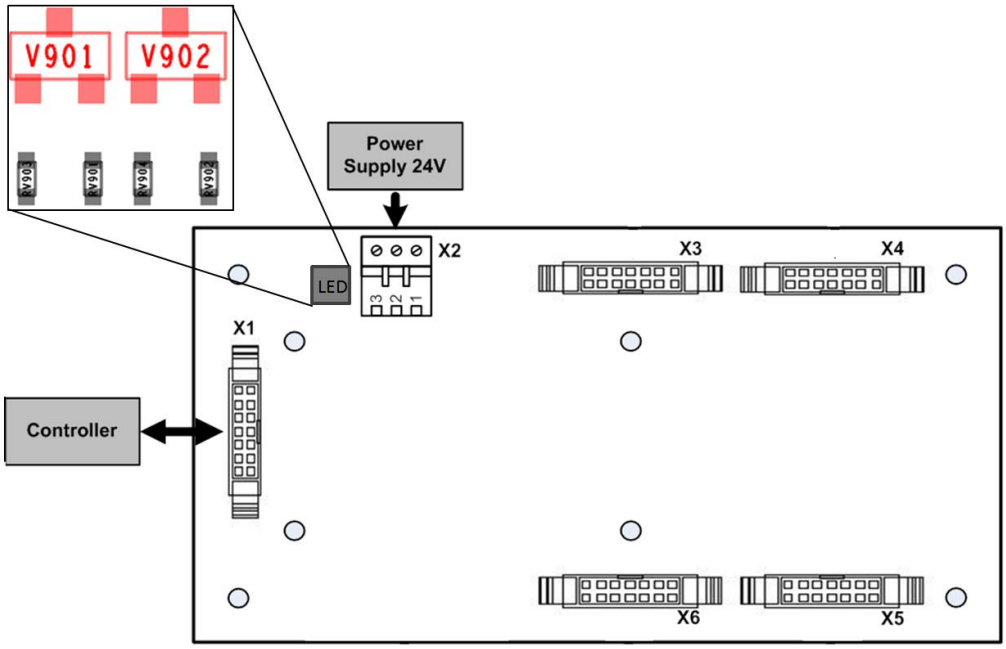
Parameters U_{TEMP}	**Specification @ -40°C <= T_a <= 85°C**
Output signal	TEMP_ANA / GND_ANA or UDC_ANA / GND_ANA
Max. output current $I_{T\text{-}out}$	5mA
Output voltage range $V_{T\text{-}Out}$	0V to 10V
Analogue temperature signal TEMP_ANA @ 115°C (typ) Alternatively analogue DC-link volatge signal. Specification see SKiiP®3 data sheet/TESKiiP®3.	10V
Analogue temperature signal TEMP_ANA @ 30°C Alternatively analogue DC-link volatge signal. @ V_{DC}=0V.	1V 0V
Amplification ratio	1 (signal ratio identical to the connected SKiiP®3)
Signal bandwidth (-3dB) (Input to Output)	Max. 50 Hz
Signal accuracy (Input to Output; over full temp. range)	± 1%[2)]

[2)] Considering the aging drift of precision input resistors the accuracy can maximal increase to ± 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 9

Figure 9: LED position on the SKiiP3 Parallel board



The description of the error indication is done in the Table 8.

Table 8: LED states and meanings

Operating mode	LED lights	
	V901	V902
IDLE (no clocking, no error)	grün	grün
By clocking and no error	grün	orange
By clocking and Error	rot	orange
No clocking and Error	rot	grün

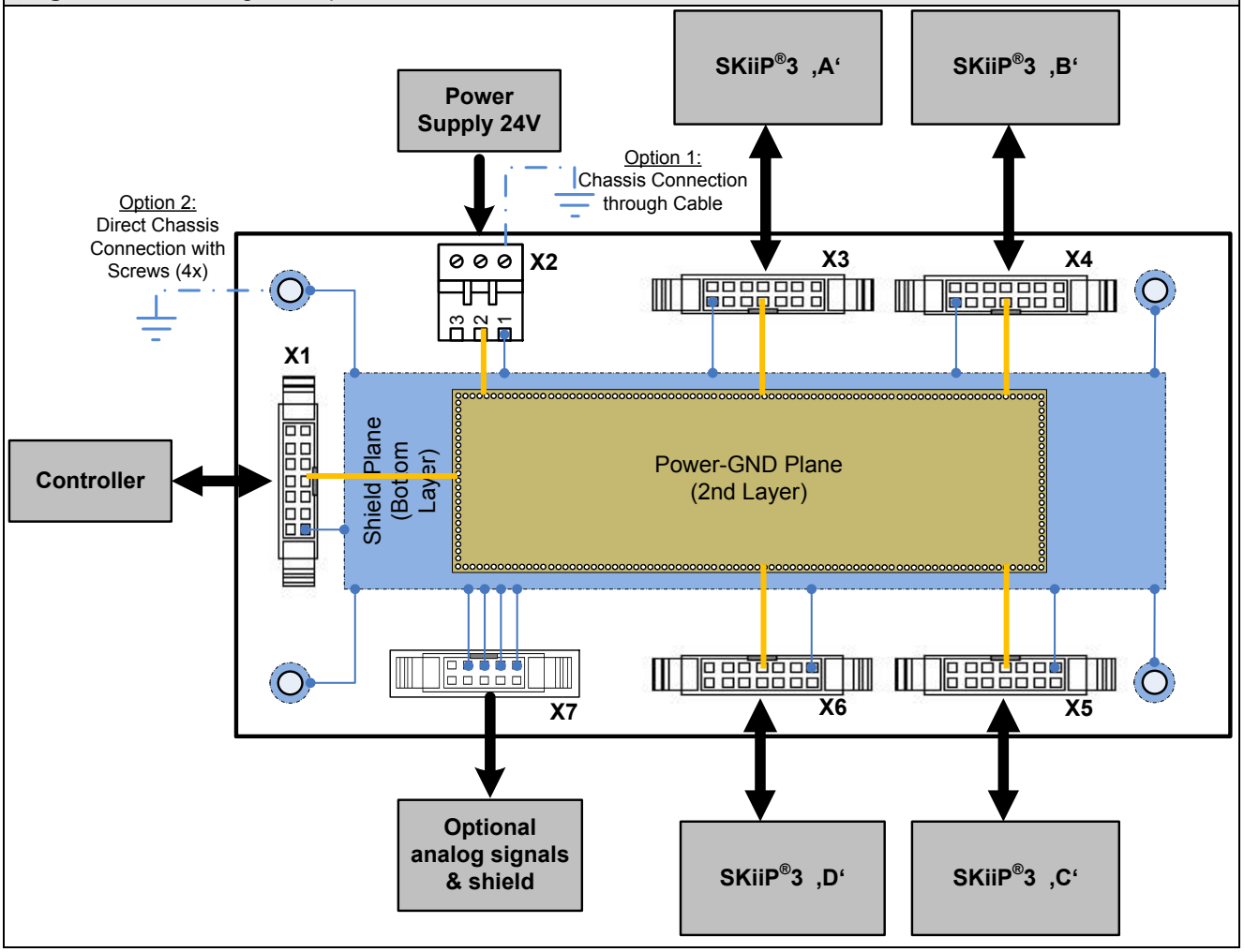
Please note: Only above listed states are possible in regular operation mode. If some other state is present, there is no supply voltage for the board or the LED/LEDs are out of functioning.

11 Interlock time

Generation of dominant Interlock time for all connected SKiiP®3 (See data sheet Parallel board SKiiP®3). Thus the internal Interlock time (t_{TD}=3 µs) of SKiiP®3 subsystems is not valid anymore. The SKiiP®3 Parallel Board sets the dominant interlock time t_{TD}=4µs for all SKiiP®3 subsystems.

12 Shielding Concept

Figure 10: Shielding concept of the SKiiP®3 Parallel board



The shield from all DIN41651 connectors (X1/X3/X4/X5/X6/X7) and the power connector (X2) is centrally merged with the shield plane within the board.
The shield plane is directly connected with the power ground plane by vias. These vias are placed alongside each egde of the PCB.
It is recommended for good EMC robustness to connect the shield plane respectively the Power-GND to chasses. That can be done on the parallel board or on controller. If grounding is done on both sides controller and on parallel board then the impedance between the both grounding points has to be low to prevent interferences.
Grounding should be done with a HF-compliant connection. There are two ways to connect the shield layer to the Chassis/PE:

Chassis-shield connection Option 1: Attaching a cable or earth strap to the rear panel metal frame and connecting it at the other end to pin 1 of connector X2. This option should be considered if the board is not attached to the rear panel metal frame with screws.

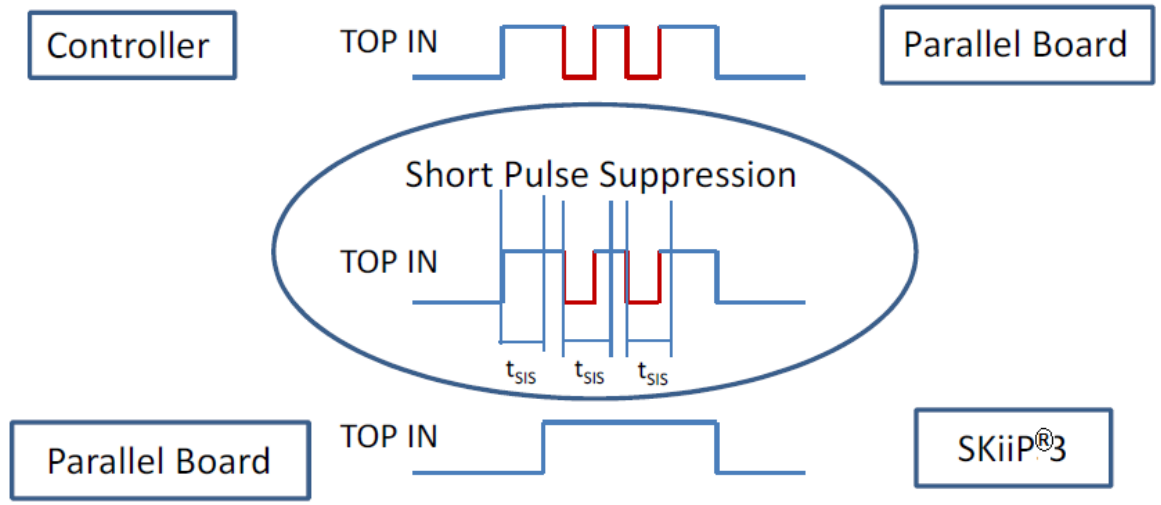
Chassis-shield connection Option 2: Connecting the SKiiP®3 parallel board to the rear panel metal frame with 4 metal screws. Electrical connection is done through metal screws. This is the prefered option for good ground connection.

Please note: The shield connection should be performed with metal screws with head diameter less than 8 mm.

13 Short pulse suppression and pulse extension

The short pulse suppression time is defined as t_{SIS} in the SKiiP®3 Parallel board data sheet. The function suppresses short turn-on and off-pulses at the pins TOP IN and BOT IN of the DIN connector of connected SKiiP®3 subsystems. Thus it adds to every commutation ~ 625ns delay time.
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}=625ns but shorter than 1µs, it will be automatically extended to 1µs by the Parallel board. Otherwise it is possible, that the rest of pulse after short pulse suppression of Parallel board will be faulty determined by the SKiiP®3 as spurious noise and will be suppressed. The short pulse suppression and extension are shown in the Figure 11.

Figure 11: Short pulse suppression and extension



14 Paralleling of SKiiP systems

Please refer to SKiiP®3 Technical Explanation Rev.2 Chapter “Paralleling of SKiiP” for further information.

15 Mounting of SKiiP®3 F-Option

For mounting of SKiiP®3 F-Option the following components could be used:
Plastic standoff adapters: round, length 20 mm, screw thread M4, material Polyamid 6,6, diamether 8 mm (for example: 05.44.320)
Plastic round head screw: M 4 x 8, DIN 85/ISO 1580, PA 6.6, trench (for example: 01.45.436)
Plastic screw nut: M4 metric (Example: 02.05.049)

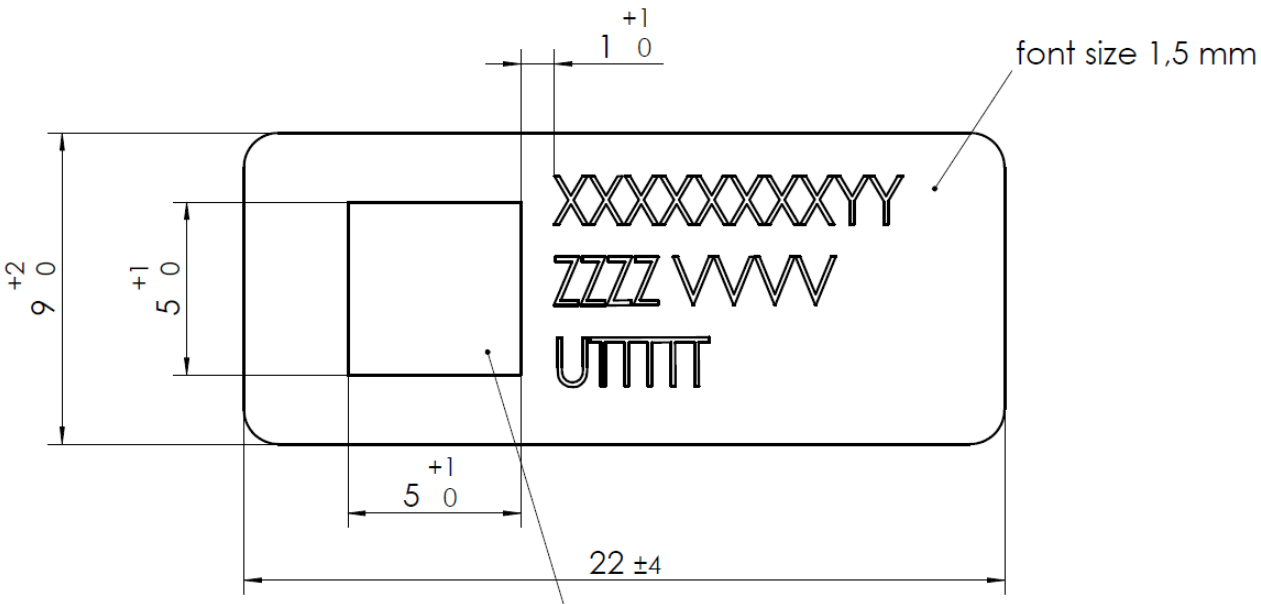
As long as a SKiiP®3 F-Option is mounted on a SKiiP®3 Parallel board, it will be supplied by the internal 15V supply voltage from the connector X1.

Table 9: Digital signal characteristic of +15V separate supply

Parameters +15V Separate Supply	**Specification @ -40°C <= T_a <= 85°C**
Ouput signal	+15V_{DC} OUT at connector X1
Circuit supply voltage	V_S (+15V ±4% / max. 50mA)

16 Logistics

Figure 12: Part Marking Information



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

17 Provisions and handling after use

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

List of figures:

List of tables:

Symbols and Terms

A detailled explanation of the terms and symbols can be found in the "Application Manual Power Semiconductors" [2]

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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