SNV018EC.XX

Current Measurement Card family

User and Installation Manual

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Document Follow-up

Action	Name	Function	Date	Signature
Written by:	Georgiadis Thanos	Engineer	15/05/2011	
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Verified by:				

Versions

Indices	Date	Modification
V1.0	18/07/2011	Initial Draft Version.
V2.0	02/11/2011	New sections added.
V3.0	09/01/2012	New template format and minor adds.
V3.1	18/01/2012	Card power consumption

Table of Contents

Card Specifications

System overview

The SNV018EC card is a DC current measurement & monitor card with an additional sense input. It is designed to be used in systems where the current monitoring is necessary, for example it can be used in photovoltaic parks with central inverters in order to monitor string currents.

The SNV018EC card is manufactured in four versions of 8, 12, 16 or 24 channels of DC current measurement.

The SNV018EC offers the following:

- 8, 12, 16, 24 isolated channels of dc current measurement (common low side)
- 0-13.5A measurement ranges (other ranges are available on demand)
- Very Low Sensing resistance on measurement channels: 10mΩ
- Measurement channels voltage up to 1000Vdc
- 1kHz sampling per channel
- 1 contact input
- Board temperature measurement
- On board long time averaging and integrations
- Communication using MODBUS over RS485
- Up to 127 cards connected in series
- Board power consumption < 1.5W
- Operating temperatures : -20°C to +60°C
- CE: EMC: EN61326-1 and Safety: EN61010-1

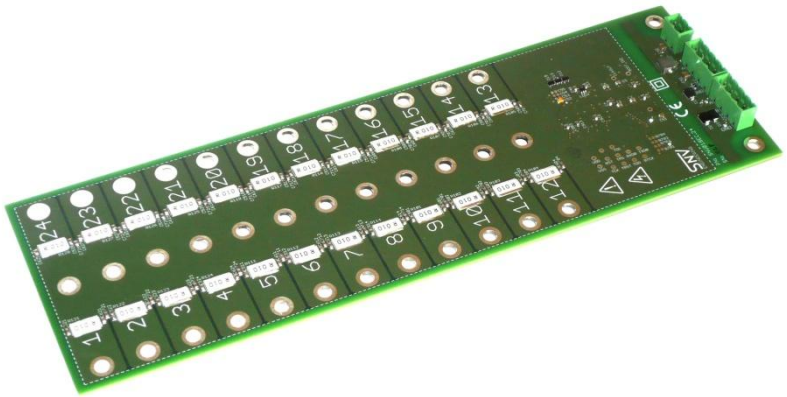

Figure 1: SNV018EC.24 Card

The card offers 8, 12, 16 or 24 channels of DC current measurement. Low side terminal is common, hence, card is suitable for high side measurement (connecting positive cable to the card). Current measurement terminals are isolated from power supply and bus terminals.

In order to perform the measurements, low thermal drift, shunt resistors are used. Voltage on them is amplified through precision amplifiers and then sampled and processed by a 32bit CORTEX-M3 microcontroller at 96MHz.

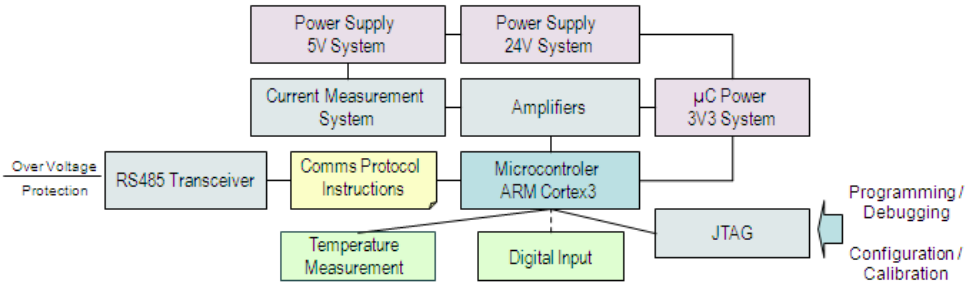

Figure 2: CMC SNV018EC Functional Diagram.

The microcontroller can deliver measurements through a serial RS485 transceiver using Modbus protocol. It can also hold values, in order to perform simultaneous measurements through all the cards in a bus and then retrieve all the measurements. The microcontroller is also calculating the average of the currents and of their square, with 1kHz sampling for each channel. The averaging period is indicated-marked by a master controller broadcast command. Averaged values of different cards are synchronized and then collected. Bandwidth consumption on the bus is limited, giving the ability for a prompt response of the rest requests.

An additional input is also implemented to monitor a switch or a sensor acting as a switch (ex. surge protection, door opening etc.).

Board temperature is also measured and provided.

Specifications

Electrical

	note	min	nom	max	Unit
Power supply		18	24	30	V dc
Consumption: *24V DC – 0A all 24 channels* *24V DC – 13.5A all 24 channels* *18V DC – 0A all 24 channels* *18V DC – 13.5A all 24 channels* *18V DC – 16A all 24 channels*	 Note 1, 2 Abs Max		 21 45 29 68	 30 54 39 79 86	mA
Measurement channel resistance	each			12	mOhm
Channel maximum current		-16		16	A
Channel max working voltage	Note 3			1000	V dc
Current measurement range	Note 4	0.035	-	13.5	A

Note 1: The value is for each installed board

Note 2: The maximum number of cards to be installed in series is 127.

Note 3: Maximum working voltage 1000VDC for pollution degree 1. For pollution degree 2 the maximum working voltage is 800VDC.

Note 4: For software version > 2.1 values lower than 35mA are pulled down to zero

Physical & Environmental Characteristics

	Details
Operating Temperature	-20 °C to +60 °C
Storage Temperature	-40 °C to +100 °C
Board Dimensions	08 channels: 165x100 mm 12 channels: 201x100 mm 16 channels: 237x100 mm 24 channels: 309x100 mm See mechanical Specifications in ANNEX A
EMC – Emissions	Meets: EN 61326-1, EN 61000-6-3, EN 50081-1, EN 55011 (Class B ITE: domestic environment)
EMC – Immunity	Meets: EN 61326-1, EN 50082-1, EN61000-4-3 (Radiated EM fields immunity) EN61000-4-4 (Fast transient burst (EFT)) EN61000-4-5 (Surges) EN61000-4-6 (Conducted EM fields immunity) Also successfully tested (Criterion A) at Conducted immunity at 10Vrms, and Radiated immunity at 10V/m (instead of 3Vrms and 3V/m required from the above standards)
Safety	Meets EN 61010-1
Measurement Category	RATED CLASS I and RATED TRANSIENT OVERVOLTAGES 1,5KV
Usage	Indoor or outdoor use installed in a metallic and/or plastic box

Measurement Characteristics

Maximum averaging time	15 days at 1kHz sampling
Measurement Accuracy	±1% of measurement current
ADC resolution (12bit)	3.3mA
Thermal Drift on board compensated (Note 5)	0.04‰ / °C
Calibration current	at 5.5 A

Note 5: Compensation, even for averaged values, is performed before value transmission using actual board temperature, measured by the on board temperature sensor. Long time averaging with large temperature variations could produce thermal drifts on the transmitted values respectively.

Communications and bus Characteristics

Hardware layer	RS485
Communication Protocol	Modbus RTU
Default baudrate	9600 bps
Max number of nodes	128
Max suggested cable length	1200 m
Protected from Overvoltage Line Faults up to	±60V
Clamp diodes (A and B to GND)	±30V
Bus Short-Circuit Protection	Yes

Card Description

The card is separated in two main areas (see figure 3).

The one (left) is dedicated to the measurement of the current passing through the card. This area is a high voltage area, where signals up to 1000Vdc exist.

CAUTION

To the card will be connected high voltage signals (up to 1000Vdc)

The operation and installation of the card is considered to be done from qualified personnel

The high side is connected to current input channels 1 – 8, 12, 16 or 24, so that the current flows as shown in figure 3, to the current channels common terminal.

The other area (right) is the low voltage area. The Modbus interface and card power supply are connected to this area. The low voltage area is protected through a F1, 1A fuse (P/N: SF-1206F100-2)

The low voltage and high voltage areas are separated by an isolation area.

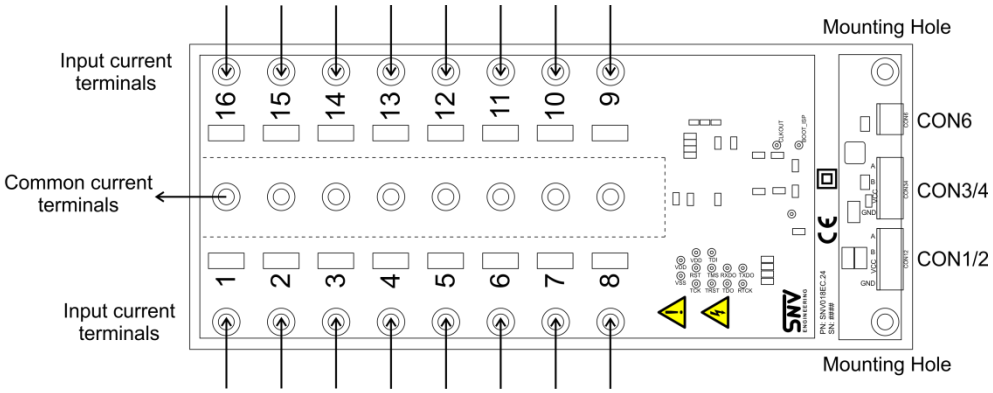

Figure 3: CMC SNV018EC Topology Diagram.

The CMC SNV018EC uses the connectors CON1/CON2 and CON3/CON4 to connect to the bus .and power supply (see table 1).

These connectors are equivalent (terminals are common) and can be used as bus/power supply input or output to the next card in the chain.

Connector CON6 has two pins which are dry contacts. The connector CON6 is used to monitor a switch or a sensor acting as a switch (ex. surge protection, door opening etc.).

CAUTION

At the connectors CON1/CON2, CON3/CON4 and CON6 should be connected only to safety extra low voltage systems.

The connections for the connectors CON1/CON2, CON3/CON4 and CON6 are listed in the table 1.

Connector	Pin Number	Description	Comments
CON6	Pin 1	Pin1	Dry contact input
	Pin 2	Pin2	
CON3/CON4	Pin 4	BUS A	TxD+/RxD+
	Pin 3	BUS B	TxD-/RxD-
	Pin 2	VCC	24Vdc
	Pin 1	GND	Ground
CON1/CON2	Pin 4	BUS A	TxD+/RxD+
	Pin 3	BUS B	TxD-/RxD-
	Pin 2	VCC	24Vdc
	Pin 1	GND	Ground

Table 1: CMC Connectors Description

The connector plugs used are equivalent to the ones listed in the following table:

Connector Ref	Manufacturer	Manufacturer P/N
For CON1/CON2	Weidmüller	BL 5.08/04/180 SN or BX
For CON3/CON4	Weidmüller	BL 5.08/04/180 SN or BX
For CON6	Weidmüller	BL 5.08/02/180 SN or BX

Table 2: CMC Connectors Description

Ordering Information

Listed below are part numbers for the Current Measurement Card SNV018EC and available accessories.

Item	Part Number
CMC SNV018EC	SNV018EC.XX
Common bar conductor (according to drawings, see ANNEX A)	SNV018.XX.0020
Mounting bar, current terminals (according to drawings, see ANNEX A)	SNV018.XX.0021
Mounting bar, common terminals (according to drawings, see ANNEX A)	SNV018.XX.0022
Bolt Holding Bar (according to drawings, see ANNEX A)	SNV018.XX.0023

Table 3: CMC ordering information

Where XX should be filled according to the table below:

XX	Channels Number
08	8 Channels
12	12 Channels
16	16 Channels
24	24 Channels

Table 4: Channel indicators

Card Installation

System overview

The below installation procedure is proposed by SNV Engineering in order to ensure the good and safe operation of the card.

In case that the described procedure is not followed SNV Engineering is not responsible from any caused damages or injury.

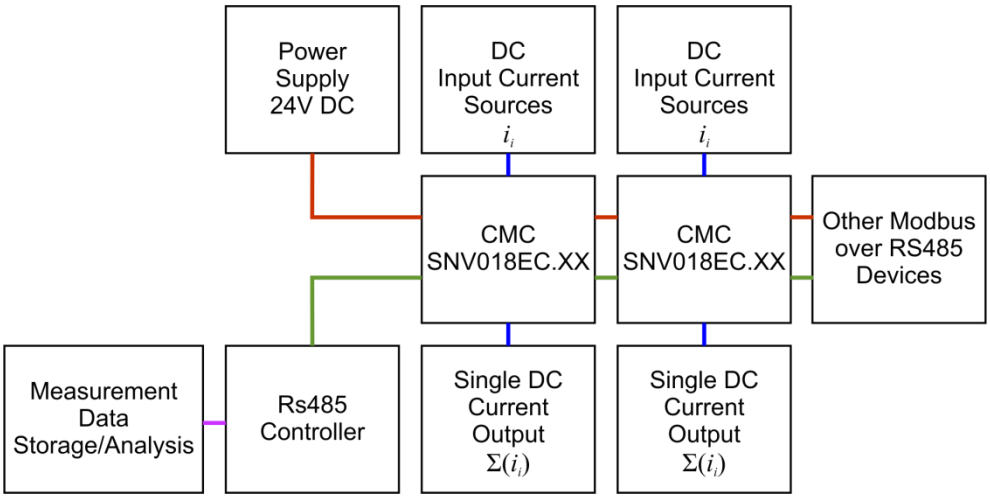

Figure 4: System Overview

SNV018EC card has up to 24 DC current measurement channels with current output terminal common (terminal holes in the center of the card).

CAUTION

To the card will be connected to high voltage signals (up to 1000Vdc)

The installation is considered to be done from qualified personnel

The card should be installed in such a way that there is no access to it by hand neither from the cables part nor from any other place

CAUTION

The card must be installed following the below restrictions:

>= 8mm gap from grounded plates

>= 15mm gap from non-grounded plates

Note: The gap is defined as the distance between relevant plate, or other element and the card routes, or components' pins, or the highest component mounted on the card, including any other conducting element, like bolts, nuts, bar, cables and cable terminals fixed on the card

Connector CON6 is a dry contact input, having two states depending the contact of the connector's two pins or not.

CAUTION

No voltage should be applied to any of the two pins of CON6

SNV018EC card uses RS485 bus for data communication. Cards are connected to the bus in series using twisted pair cable. Card has two equivalent connectors (CON1/CON2 and CON3/CON4) to facilitate connection of multiple cards in series.

It is suggested to connect all cards in series in a "line", preferable with the master controller in the middle. If not convenient a star topology, with the master controller in the center, may work depending of the cable length, the number of the lines, and their relative lengths. In any case all the terminal nodes must be terminated with the appropriate resistor (see Annex B). Bias resistors also must be installed (see Annex B).

RS485 transceiver used supports up to 128 nodes; hence up to 127 boards can be connected to the same bus. The total length of the cable used for the boards interconnection is suggested not to exceed 1200m, when bus repeaters are not used.

The same cable can be used for the power supply of the cards, using an extra pair. The power supply source should be 24Vdc and the current capacity should not exceed 5A. It is suggested, where the number of cards allow, to use a power supply of 1A, since the on-board PCB fuse is 1A rated. A clamp diode is installed at power supply terminals after the on-board PCB fuse. If power supply polarity is wrong, current will be conducted through the diode, blowing the fuse.

Inspection and handling

Visually inspect the CMC SNV018EC before installing it, for any defect or damage.

Immediately notify the carrier if any damage is apparent.

CAUTION

Proper ESD handling procedures must always be used when packing, unpacking or installing the card. Failure to do so may cause damage to the unit.

Preparation

Card mounting and support

Current measurement channel and common terminals are to be connected with M5 bolts through ∅5.5 holes on the card. Those holes can be used at the same time for card mounting. There are also two additional holes at the plug connector side only for mounting.

The card can be mounted using “mounting bars” (see ordering information and drawings in ANNEX A). Alternatively, the card can be fixed using spacers. The card can be also fixed through the common bar conductor and two spacers using the two holes at the plug connector side. If “mounting bars” are not used it is suggested to use “bolt holding bar” (see ordering information and drawings), in order to be able to tide the nuts, or change a ring terminal, once the card installed.

If other material is applied, than those supplied by SNV, the following specifications should at least comply:

- ensure following gap, defined as the distance between relevant plate, or other element and the card routes, or components’ pins, or the highest component mounted on the card, including any other conducting element, like bolts, nuts, bar, cables and cable terminals fixed on the card.

  >= 8mm gap from grounded plates

  >= 15mm gap from non-grounded plates

- ensure dielectric strength >3.5kV
- ensure flammability rating better than 94V1.
- ensure operating temperature range and aging strength depending application specifications.

In any case, all bolts must be tide, to ensure the conductivity. Use star washers between ring terminal or common bar and bolt head or nut. Do not apply star washer directly on the card.

Housing preparation

The box where the card is installed is considered to be a metallic and/or plastic box.

Inside, the plate of the box is suggested to have a drilling pattern like the one shown in figure 4, for the mounting of the card when using “mounting bars” (see also ANNEX A). Consult drawings (see ANNEX A) for the drilling pattern of the card it self.

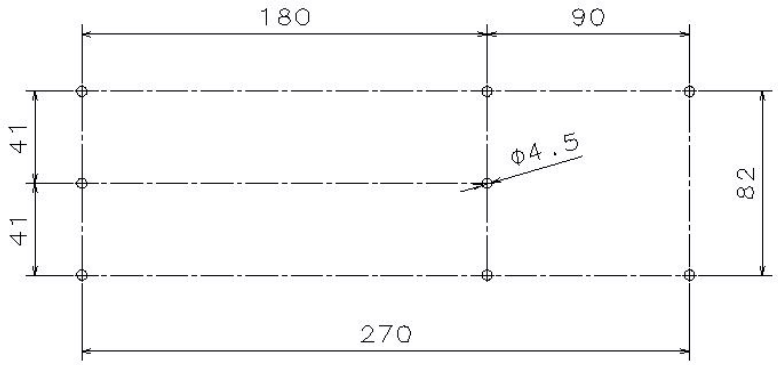

Figure 5: Drilling pattern

Current measurement channel protection

The cables should be properly selected and sized according to the application specifications. Voltage must not exceed 1000VDC. A fuse must be installed for each current measurement channel separately, with rated current up to 16A.

CAUTION

Voltage must not exceed 1000VDC. A fuse must be installed for each current measurement channel separately, with rated current up to 16A.

For the preparation of the cables connected to the current channels the IPC-620 have to be followed by the installer.

The cables should be connected to the current channels using ring terminals and star washers above the ring terminal.

Connectors plug preparation

The connector plugs to be used are those listed in table 2 or equivalent.

For the preparation of the cables connected to the plugs the IPC-620 have to be followed by the installer.

Plugs should be connected with cables before plugged to the card.

Installation

During the installation of the card any power source is prohibited.

In the case that “mounting bars” are used, the proposed installation steps for the SNV018EC.24 are the following and illustrated in the figures 6 to 11,:

1. Mount the two mounting bars SNV018.24.0021 and the mounting bar SNV018.24.0022 on the plate as shown in figure 6. Use bolts M4x10 alen (DIN912) with nut.
2. Place the card on the fixing bars as shown in figure 7. Mount the card on the plug connectors side using M5x10 (DIN912 or DIN933) bolts.
3. Mount the common bar SNV018.24.0020 on the CMC SNV018EC using M5x10 (DIN912 or DIN933) bolt and star washers (DIN6798A) as shown in figure 8.
4. Mount the current measurement cables on the CMC SNV018EC using M5x10 (DIN912 or DIN933) bolt and star washers (DIN6798A) as illustrated in figure 9.
5. Mount the common current cable on the common bar using M5x10 (DIN912 or DIN933) bolt and star washers (DIN6798A), as illustrated in figure 10.
6. Plug connectors CON1/CON2, CON3/CON4 and CON6 on the card as shown in figure 11.

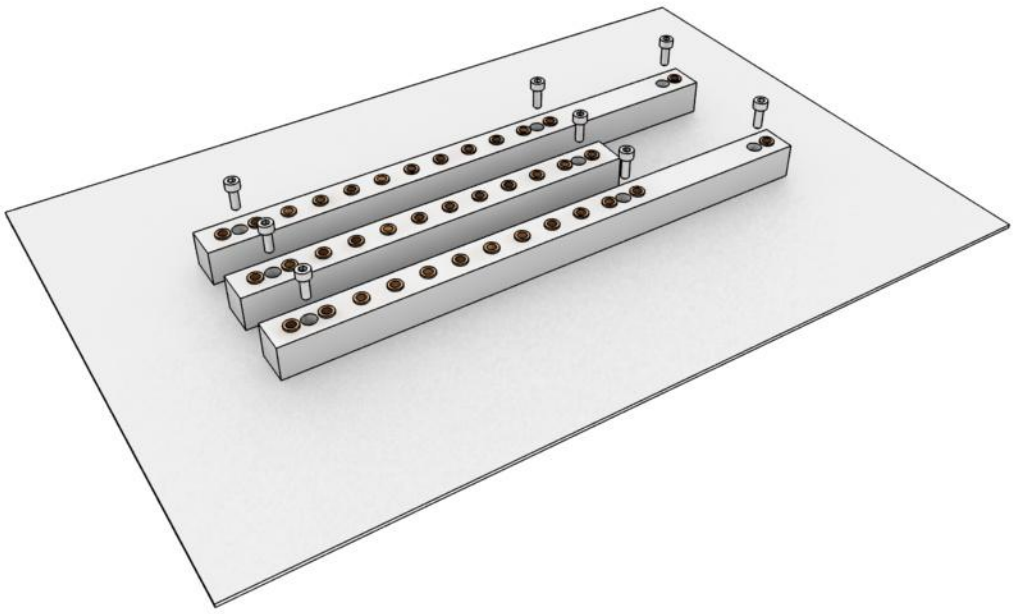

Figure 6: Mounting of the fixing bars

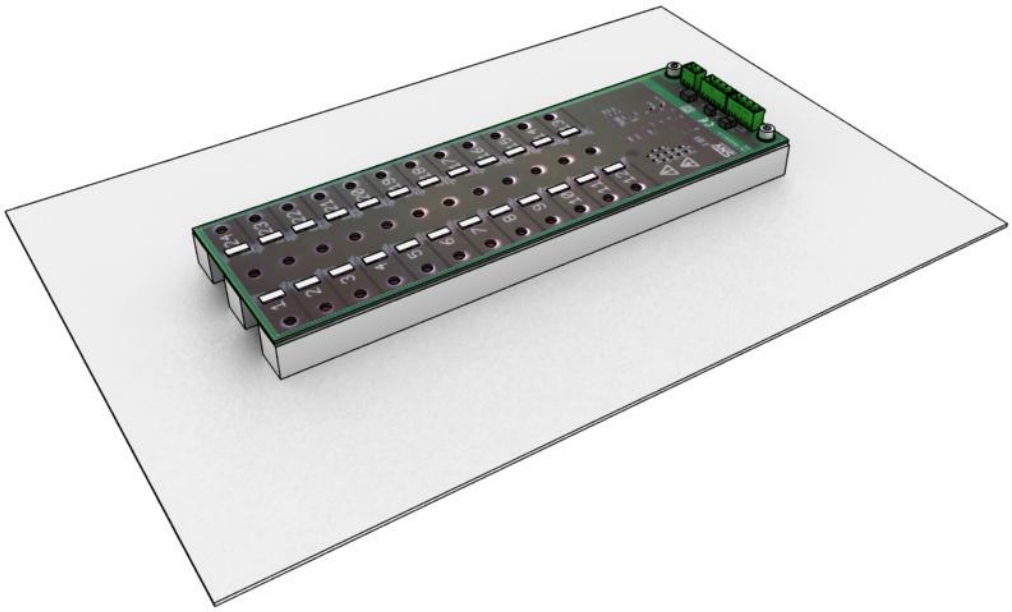

Figure 7: Placing the card on the mounting bars

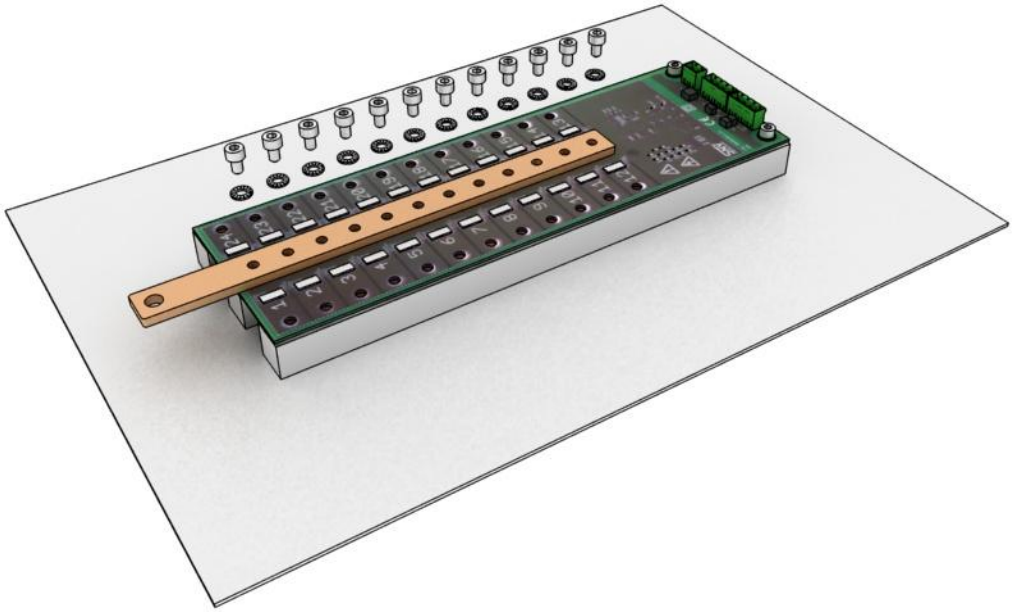

Figure 8: Mounting the common bar on the CMC SNV018EC

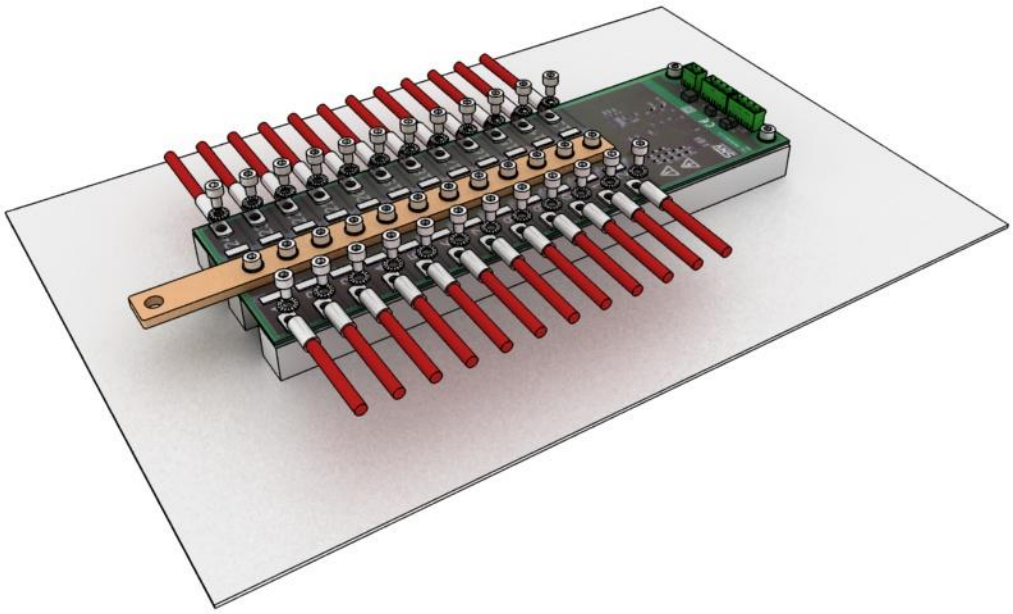

Figure 9: Mounting of the current measurement cables

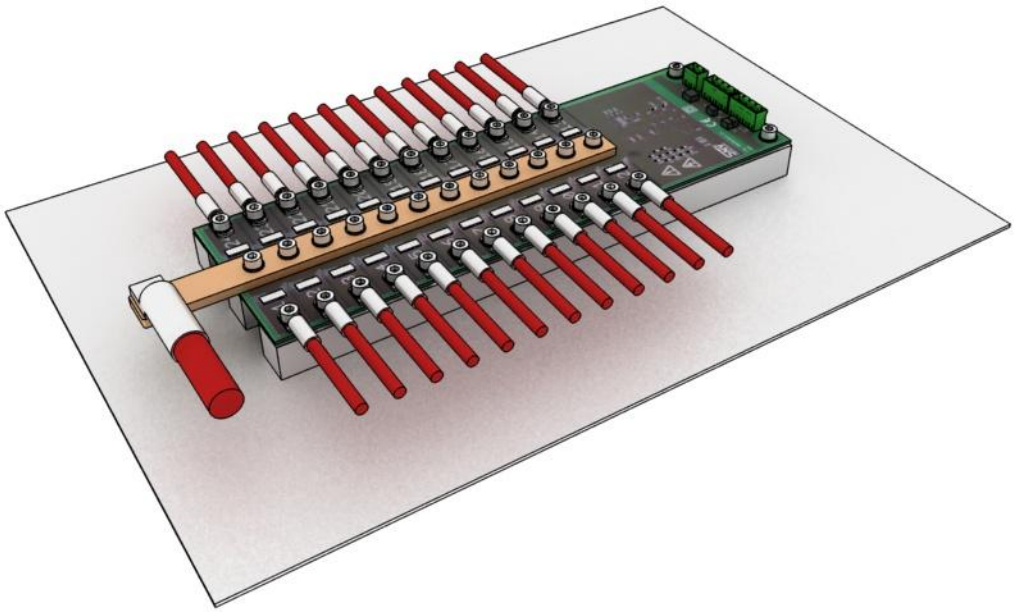

Figure 10: Mounting the common current cable on the CMC SNV018EC

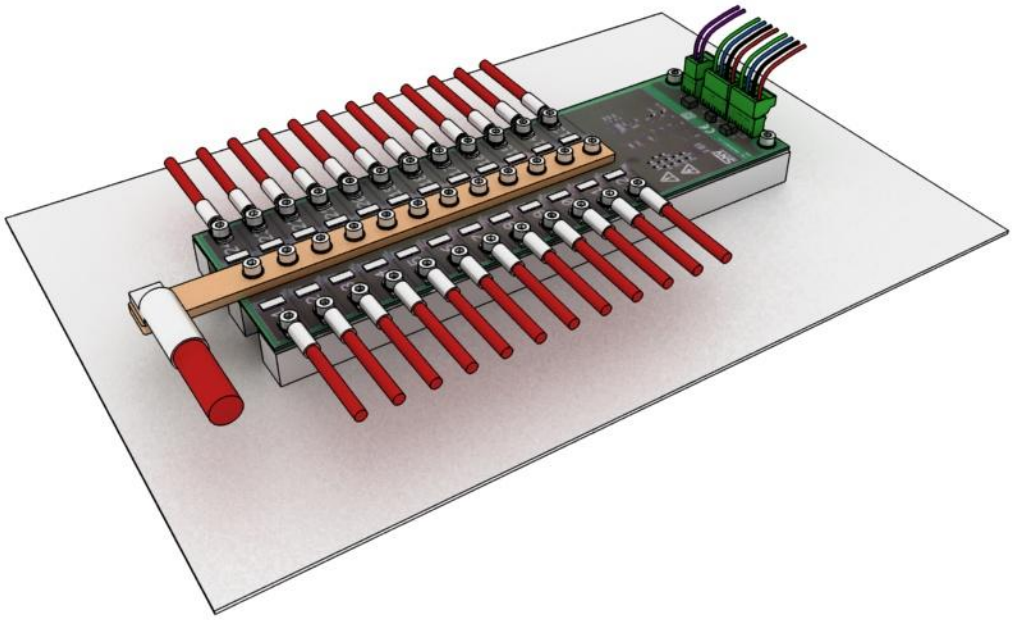

Figure 11: Plug the connectors on the card

For the other boards of the family SNV018EC the steps are identical and the mechanical parts for the mounting of the board are in accordance with the drawings in ANNEX A.

The illustration of the “bolt holding bar” use follows:

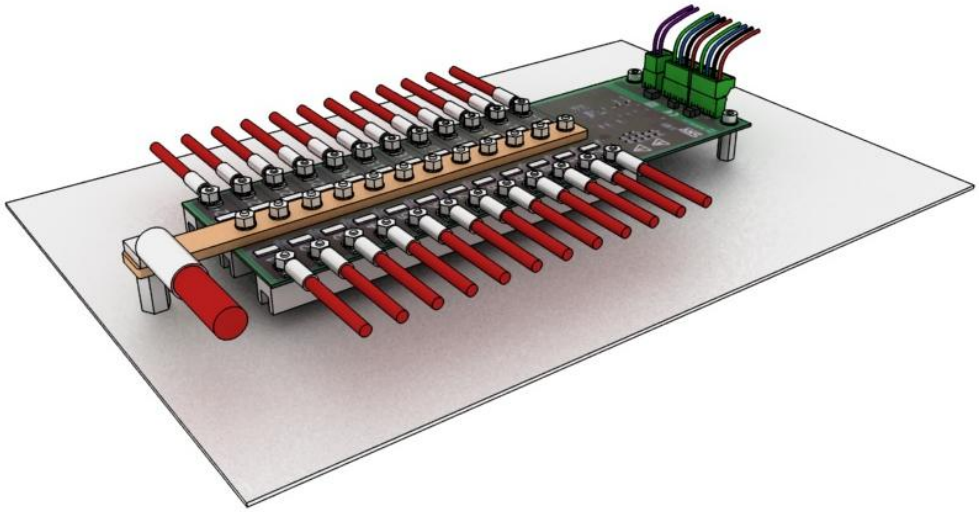

Figure 12: Alternative mounting figure with "bolt holding bars"

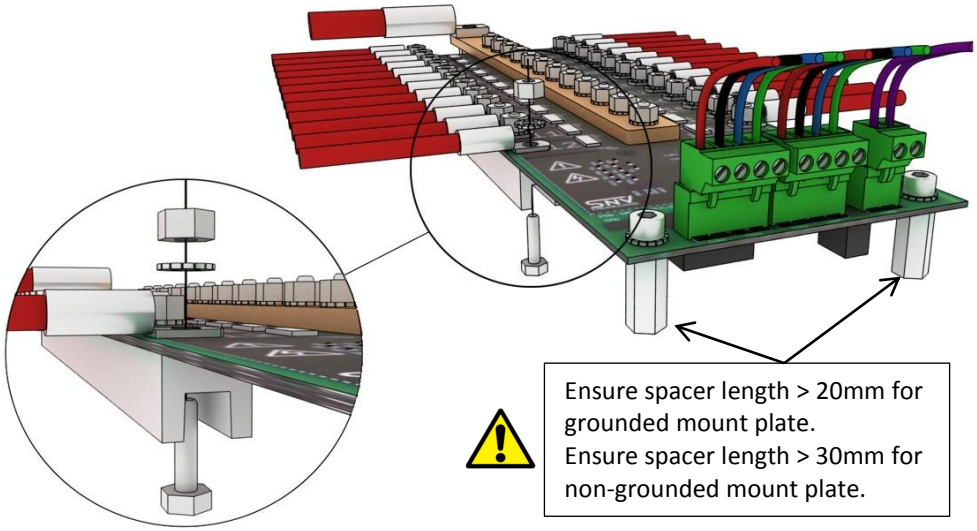

Figure 13: Detail view of "bolt holding bar" mounting

Safety

Safety instructions

The Current Measurement Card SNV018EC is designed and manufactured to be functionally safe for persons who operate or service it. Potential hazards are addressed by a combination of careful system design and appropriate warning labels.

However, during its operation, high voltages apply on the card. As a consequence, the card is capable of causing serious personnel injury and damage to equipment, if installed, operated, or serviced improperly.

CAUTION

To the card will be connected high voltage signals (up to 1000Vdc)

The installation is considered to be done from qualified personnel

The card should be installed in such a way that there is no access to it by hand neither from the cables part nor from any other place

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CAUTION

The card must be installed following the below restrictions:

>= 8mm gap from grounded plates

>= 15mm gap from non-grounded plates

<u>Note:</u> The gap is defined as the distance between relevant plate, or other element and the card routes, or components' pins, or the highest component mounted on the card, including any other conducting element, like bolts, nuts, bar, cables and cable terminals fixed on the card

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SNV does not assume liability for the customer's failure to comply with established procedures. Read this chapter before you perform any operations or installation of the card.

If the equipment used in a manner not specified by the instructions of user manual, the protection provided by the card may be impaired.

SNV's equipment is designed to, and reviewed, against to CE Safety and EMC standards. These standards incorporate applicable electrical codes and safety regulations.

This manual contains information and warnings which users must follow for safe operation and to keep the apparatus in safe condition.

Even when the apparatus is not connected to its power supply, terminals can be electrically live, and the opening of covers or removal of parts is likely to expose live parts.

The card must be disconnected from all voltage sources before it is disassembled for any adjustment, replacement, maintenance, or repair.

The following symbols appear in various places on the card to call your attention to hazards or to indicate that you should consult the manuals for further information.

Safety Symbols

Double insulation or reinforced insulation.

CAUTION RISK OF ELECTRIC SHOCK

CAUTION RISK OF DANGER

Note When an equipment is marked with this symbol the documentation must always be consulted, in order to find out the nature of the potential HAZARD and any actions which have to be taken

Card Operation

For communication, MODBUS protocol over an RS485 serial line is implemented (RTU mode @9600bps). See further “MODBUS Application Protocol Specification v1.1b” and “MODBUS over Serial Line Specification and Implementation Guide v1.02”.

Data can be read through “16bit input registers”. Commands are send by writing “Holding registers”. Three commands are implemented: “hold”, “mark” and “change address”. Hold command transfer “instant current” values to “current holded values”. Command can be send with a broadcast write, acquiring a snapshot of all the currents from all the cards in the bus.

Mark command initiates averaging and at the same time terminates previous averaging and transfers the result to the relevant registers. It is suggested to broadcast periodically the “mark” command, with the desired period (as for example 10 mins), and during each period read and store the averaged data.

Modbus Memory Map

The memory map of the card is describing in the following table:

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
0	0x 000	float	Amperes	instant current	1
1	0x 001				
2	0x 002	float	Amperes		2
3	0x 003				
4	0x 004	float	Amperes		3
5	0x 005				
6	0x 006	float	Amperes		4
7	0x 007				
8	0x 008	float	Amperes		5
9	0x 009				
10	0x 00A	float	Amperes		6
11	0x 00B				

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
12	0x 00C	float	Amperes		7
13	0x 00D				
14	0x 00E	float	Amperes		8
15	0x 00F				
16	0x 010	float	Amperes		9
17	0x 011				
18	0x 012	float	Amperes		10
19	0x 013				
20	0x 014	float	Amperes		11
21	0x 015				
22	0x 016	float	Amperes		12
23	0x 017				
24	0x 018	float	Amperes		13
25	0x 019				
26	0x 01A	float	Amperes		14
27	0x 01B				
28	0x 01C	float	Amperes		15
29	0x 01D				
30	0x 01E	float	Amperes		16
31	0x 01F				
32	0x 020	float	Amperes		17
33	0x 021				
34	0x 022	float	Amperes		18
35	0x 023				
36	0x 024	float	Amperes		19
37	0x 025				
38	0x 026	float	Amperes		20
39	0x 027				
40	0x 028	float	Amperes		21
41	0x 029				
42	0x 02A	float	Amperes		22
43	0x 02B				
44	0x 02C	float	Amperes		23
45	0x 02D				
46	0x 02E	float	Amperes		24
47	0x 02F				
48	0x 030	float		not used – returns zero	
49	0x 031				
50	0x 032	float			
51	0x 033				
52	0x 034	float			
53	0x 035				
54	0x 036	float			
55	0x 037				

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
56	0x 038	float			
57	0x 039				
58	0x 03A	float			
59	0x 03B				
60	0x 03C	float			
61	0x 03D				
62	0x 03E	float			
63	0x 03F				
64	0x 040	float	Amperes	current averaged	1
65	0x 041				
66	0x 042	float	Amperes		2
67	0x 043				
68	0x 044	float	Amperes		3
69	0x 045				
70	0x 046	float	Amperes		4
71	0x 047				
72	0x 048	float	Amperes		5
73	0x 049				
74	0x 04A	float	Amperes		6
75	0x 04B				
76	0x 04C	float	Amperes		7
77	0x 04D				
78	0x 04E	float	Amperes		8
79	0x 04F				
80	0x 050	float	Amperes		9
81	0x 051				
82	0x 052	float	Amperes		10
83	0x 053				
84	0x 054	float	Amperes		11
85	0x 055				
86	0x 056	float	Amperes		12
87	0x 057				
88	0x 058	float	Amperes		13
89	0x 059				
90	0x 05A	float	Amperes		14
91	0x 05B				
92	0x 05C	float	Amperes		15
93	0x 05D				
94	0x 05E	float	Amperes		16
95	0x 05F				
96	0x 060	float	Amperes		17
97	0x 061				
98	0x 062	float	Amperes		18
99	0x 063				

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
100	0x 064	float	Amperes		19
101	0x 065				
102	0x 066	float	Amperes		20
103	0x 067				
104	0x 068	float	Amperes		21
105	0x 069				
106	0x 06A	float	Amperes		22
107	0x 06B				
108	0x 06C	float	Amperes		23
109	0x 06D				
110	0x 06E	float	Amperes		24
111	0x 06F				
112	0x 070	float		not used – returns zero	
113	0x 071				
114	0x 072	float			
115	0x 073				
116	0x 074	float			
117	0x 075				
118	0x 076	float			
119	0x 077				
120	0x 078	float			
121	0x 079				
122	0x 07A	float			
123	0x 07B				
124	0x 07C	float			
125	0x 07D				
126	0x 07E	float			
127	0x 07F				
128	0x 080	float	Amperes	current squared averaged	1
129	0x 081				
130	0x 082	float	Amperes		2
131	0x 083				
132	0x 084	float	Amperes		3
133	0x 085				
134	0x 086	float	Amperes		4
135	0x 087				
136	0x 088	float	Amperes		5
137	0x 089				
138	0x 08A	float	Amperes		6
139	0x 08B				
140	0x 08C	float	Amperes		7
141	0x 08D				
142	0x 08E	float	Amperes		8
143	0x 08F				

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
144	0x 090	float	Amperes		9
145	0x 091				
146	0x 092	float	Amperes		10
147	0x 093				
148	0x 094	float	Amperes		11
149	0x 095				
150	0x 096	float	Amperes		12
151	0x 097				
152	0x 098	float	Amperes		13
153	0x 099				
154	0x 09A	float	Amperes		14
155	0x 09B				
156	0x 09C	float	Amperes		15
157	0x 09D				
158	0x 09E	float	Amperes		16
159	0x 09F				
160	0x 0A0	float	Amperes		17
161	0x 0A1				
162	0x 0A2	float	Amperes		18
163	0x 0A3				
164	0x 0A4	float	Amperes		19
165	0x 0A5				
166	0x 0A6	float	Amperes		20
167	0x 0A7				
168	0x 0A8	float	Amperes		21
169	0x 0A9				
170	0x 0AA	float	Amperes		22
171	0x 0AB				
172	0x 0AC	float	Amperes		23
173	0x 0AD				
174	0x 0AE	float	Amperes		24
175	0x 0AF				
176	0x 0B0	float		not used – returns zero	
177	0x 0B1				
178	0x 0B2	float			
179	0x 0B3				
180	0x 0B4	float			
181	0x 0B5				
182	0x 0B6	float			
183	0x 0B7				
184	0x 0B8	float			
185	0x 0B9				
186	0x 0BA	float			
187	0x 0BB				

16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
188	0x 0BC	float			
189	0x 0BD				
190	0x 0BE	float			
191	0x 0BF				
192	0x 0C0	float	Amperes	current holded values	1
193	0x 0C1				
194	0x 0C2	float	Amperes		2
195	0x 0C3				
196	0x 0C4	float	Amperes		3
197	0x 0C5				
198	0x 0C6	float	Amperes		4
199	0x 0C7				
200	0x 0C8	float	Amperes		5
201	0x 0C9				
202	0x 0CA	float	Amperes		6
203	0x 0CB				
204	0x 0CC	float	Amperes		7
205	0x 0CD				
206	0x 0CE	float	Amperes		8
207	0x 0CF				
208	0x 0D0	float	Amperes		9
209	0x 0D1				
210	0x 0D2	float	Amperes		10
211	0x 0D3				
212	0x 0D4	float	Amperes		11
213	0x 0D5				
214	0x 0D6	float	Amperes		12
215	0x 0D7				
216	0x 0D8	float	Amperes		13
217	0x 0D9				
218	0x 0DA	float	Amperes		14
219	0x 0DB				
220	0x 0DC	float	Amperes		15
221	0x 0DD				
222	0x 0DE	float	Amperes		16
223	0x 0DF				
224	0x 0E0	float	Amperes		17
225	0x 0E1				
226	0x 0E2	float	Amperes		18
227	0x 0E3				
228	0x 0E4	float	Amperes		19
229	0x 0E5				
230	0x 0E6	float	Amperes		20
231	0x 0E7				

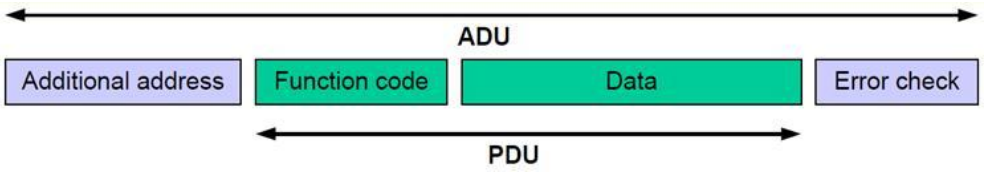
16bit input registers (use Modbus function 4)					
Address		Type	Units	Description	Channel
dec	hex				
232	0x 0E8	float	Amperes		21
233	0x 0E9				
234	0x 0EA	float	Amperes		22
235	0x 0EB				
236	0x 0EC	float	Amperes		23
237	0x 0ED				
238	0x 0EE	float	Amperes		24
239	0x 0EF				
240	0x 0F0	float		not used – returns zero	
241	0x 0F1				
242	0x 0F2	float			
243	0x 0F3				
244	0x 0F4	float			
245	0x 0F5				
246	0x 0F6	float			
247	0x 0F7				
248	0x 0F8	float			
249	0x 0F9				
250	0x 0FA	float			
251	0x 0FB				
252	0x 0FC	float			
253	0x 0FD				
254	0x 0FE	float			
255	0x 0FF				
256	0x 100	float	Celsius	temperature	
257	0x 101				

coils (use MODBUS function 1)				
Address		Type	Units	Description
dec	hex			
0	0x 00	bit	-	Dry contact input (1-contact / 0-no contact)

holding registers (MODBUS function 16)			
Address		Type	Description
dec	hex		
0	0x 00	Hi byte	Commands: "hold"(0x01) or "mark"(0x02) or "change address"(0x0A)
		Lo byte	if command is "change address", then set new target address
1	0x 01	Hi byte	if command is "change address", then set new target address
		Lo byte	if command is "change address", then set new target address

MODBUS Functions

Modbus package structure:



Implemented Modbus functions are described in the following tables.

CAUTION

Do not use functions 20 and 21.

SNV012EC.B - MODBUS Function (1)					
Function	SubFunction	Data	Length	Values	Description
1 (0x01)	-				**Read Coils**
		SA_H	1 Byte	0x00 - 0xFF	Starting Address Hi
		SA_L	1 Byte	0x00 - 0xFF	Starting Address Lo
		QI_H	1 Byte	0x00 - 0x00	Quantity of Input Registers Hi
		QI_L	1 Byte	0x00 - 0xFF	Quantity of Input Registers Lo
					Quantity: 1 to 2000 (0x07D0)

Response:					
0x01	-		2 Byte+N(2 Byte)		
		BCN	1 Byte	=N	Byte count
		RG_H	1 Byte	N byte	Coil Status
		N times Hi and Lo for N Coils			
Error Report:					
0x81			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.1

SNV012EC.B - MODBUS Function (4)

Function	SubFunction	Data	Length	Values	Description	
4 (0x04)		-				**Read Input Registers**
			SA_H	1 Byte	0x00 - 0xFF	Starting Address Hi
			SA_L	1 Byte	0x00 - 0xFF	Starting Address Lo
			QI_H	1 Byte	0x00 - 0x00	Quantity of Input Registers Hi
			QI_L	1 Byte	0x01 - 0x7D	Quantity of Input Registers Lo
Response:						
0x04		-		2 Byte+N(2 Byte)		
			BCN	1 Byte	=2xN	Byte count
			RG_H	1 Byte	0x00 - 0xFF	Register value Hi
			RG_L	1 Byte	0x00 - 0xFF	Register value Lo
			N times Hi and Lo for N Registers			
Error Report:						
0x84				2 Byte		Error
	x01		-			Function unsupported
	x02		-			Address error
	x03		-			Error in register quantity (1-125)
	x04		-			Error in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.4

SNV012EC.B - MODBUS Function (8)					
Function	SubFunction	Data	Length	Values	Description
8 (0x08)					**Diagnostics**
	0x0000	any data	3 Byte + data		Echo data (Send received data)
Response:					
0x08					
	0x0000	any data	3 Byte+ data		Echo data (Send received data)
Error Report:					
0x88			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.8

SNV012EC.B - MODBUS Function (16)					
Function	SubFunction	Data	Length	Values	Description
16 (0x10)					**Write Multiple registers**
		SA_H	1 Byte	0x00 - 0xFF	Starting Address Hi
		SA_L	1 Byte	0x00 - 0xFF	Starting Address Lo
		QR_H	1 Byte	0x00 - 0x00	Quantity of Registers Hi
		QR_L	1 Byte	0x01 - 0x7B	Quantity of Registers Lo
		BQ	1 Byte	0x00 - 0xFF	Byte Count = 2 x N
	0x0000	data	=N x (2 Byte)		Echo data (Send received data)
Response:					
0x10					
		SA_H	1 Byte	0x00 - 0xFF	Starting Address Hi
		SA_L	1 Byte	0x00 - 0xFF	Starting Address Lo
		QRW_H	1 Byte	0x00 - 0x00	Quantity of Registers Hi
		QRW_L	1 Byte	0x01 - 0x7B	Quantity of Registers Lo
	0x0000	any data	2 Byte + data		Echo data (Send received data)
Error Report:					
0x90			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.12

SNV012EC.B - MODBUS Function (17)					
Function	SubFunction	Data	Length	Values	Description
17 (0x11)					**Report Slave ID (Serial Line only)**
Response:					
0x11					
		BQ	1 Byte	0x00 - 0xFF	Byte Count
		SID	1 Byte	0x00 - 0xFF	Slave ID
		IS	1 Byte	0x00 or 0xFF	Run Indicator Status
		AD			Additional Data
Error Report:					
0x91			2 Byte		Error
	x01	-			Function unsupported
	x04	-			Erron in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.13

SNV012EC.B - MODBUS Function (20)					
Function	SubFunction	Data	Length	Values	Description
20 (0x14)					**Read File Record**
		BQ	1 Byte	0x07 - 0xF5	Byte Count
		RT	1 Byte	0x06	Sub-Req. x, Reference Type
		FN	2 Byte	0x0001 - 0xFFFF	Sub-Req. x, File Number
		RN	2 Byte	0x0001 - 0x270F	Sub-Req. x, Record Number
		RL	=N	0x0000 - 0xFFFF	Sub-Req. x, Record Length
			...		Sub-Req. x+1, ...
Response:					
0x14					
		RDL	1 Byte	0x07 - 0xF5	Resp. data Length
		RFL	1 Byte	0x07 - 0xF5	Sub-Req. x, File Resp. length
		RRT	1 Byte	0x06	Sub-Req. x, Reference Type
		RRD	N x 2 byte		Sub-Req. x, Record Data
			...		Sub-Req. x+1, ...
Error Report:					
0x94			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register
	x08	-			

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.14

SNV012EC.B - MODBUS Functions (21)					
Function	SubFunction	Data	Length	Values	Description
21 (0x15)					**Write File Record**
		RDL	1 Byte	0x09 to 0xFB	Request data length
		RT	1 Byte	0x06	Sub-Req. x, Reference Type
		FN	2 Byte	0x0001 - 0xFFFF	Sub-Req. x, File Number
		RN	2 Byte	0x0001 - 0x270F	Sub-Req. x, Record Number
		RL	=N		Sub-Req. x, Record Length
			=N x 2		
		RD	Byte		Sub-Req. x, Record data
			...		Sub-Req. x+1, ...
Response:					
0x15					
		RDL	1 Byte	0x09 - 0xF5B	Resp. data Length
		RRT	1 Byte	0x06	Sub-Req. x, Reference Type
		RFN	2 Byte	0x0001 to 0xFFFF	Sub-Req. x, File Number
		RRN	2 Byte	0x0001 - 0x270F	Sub-Req. x, Record Number
		RRL	=N		Sub-Req. x, Record length
			=N x 2		
		RRD	Byte		Sub-Req. x, Record Data
			...		Sub-Req. x+1, ...
Error Report:					
0x95			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register
	x08	-			

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.15

SNV012EC.B - MODBUS Functions (43)					
Function	SubFunction	Data	Length	Values	Description
43 (0x2B)					**Encapsulated Interface Transport**
	x0E				**Read Device Identification**
				0x01 to 0x04	Read Device ID code
				0x00 to 0xFF	Object Id
Response:					
0x2B					
	x0E				
		RDID	1 Byte	0x01 to 0x04	Read Device ID code
				0x01 to 0x03	
			1 Byte	0x81 to 0x83	Conformity level
			1 Byte	0x00 or 0xFF	More Follows
			1 Byte	0x00 to 0xFF	Next Object Id
			1 Byte	0x00 to 0xFF	Number of objects
					List Of
			1 Byte	0x00 to 0xFF	Object ID
			1 Byte	0x00 to 0xFF	Object length
				Length	Object Value
Error Report:					
0xAB			2 Byte		Error
	x01	-			Function unsupported
	x02	-			Address error
	x03	-			Error in register quantity (1-125)
	x04	-			Erron in reading register

according to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b - paragraph 6.21

Technical Assistance

If you need technical assistance or should it be necessary to return your product for repair or calibration use the contact details below:

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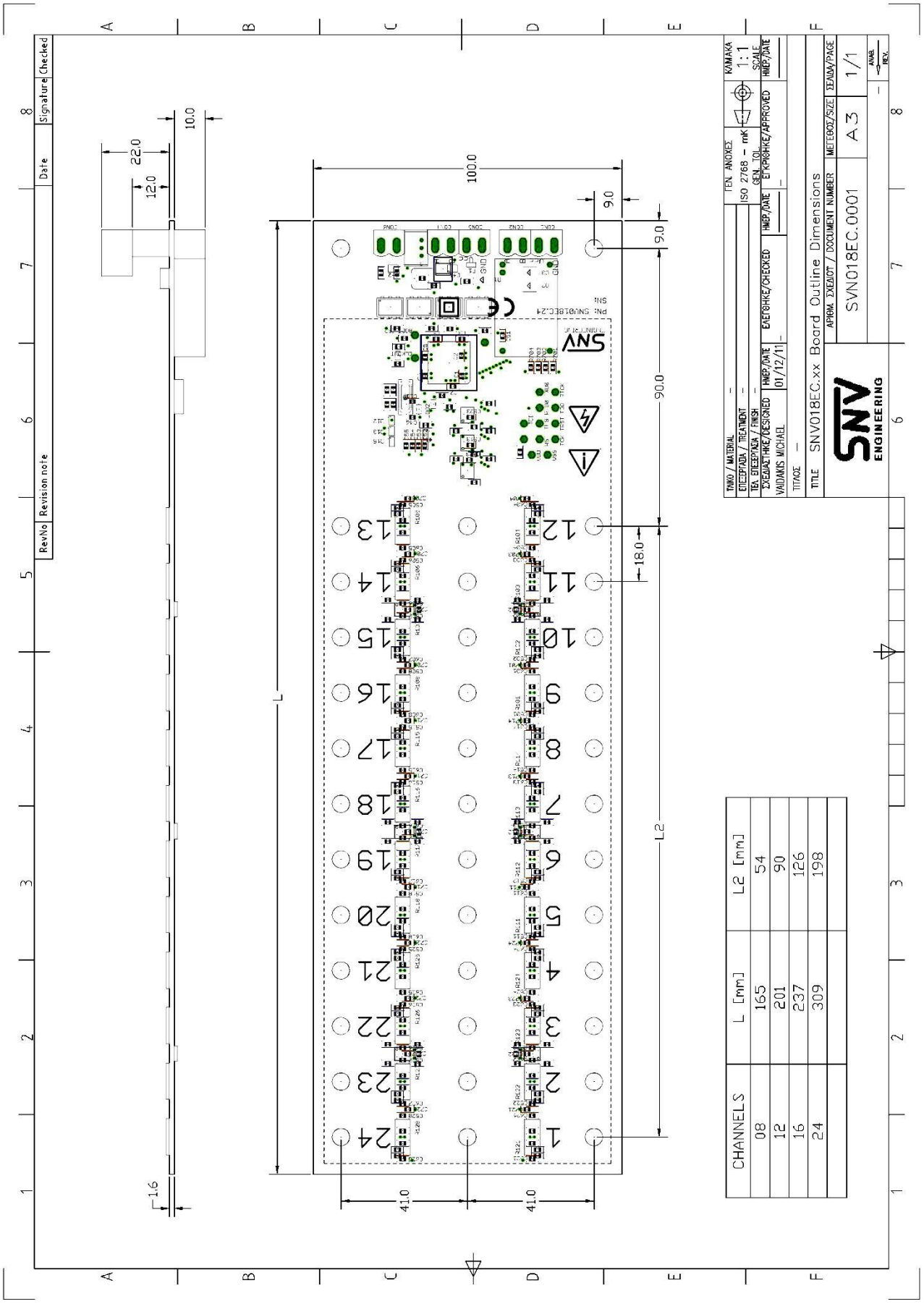
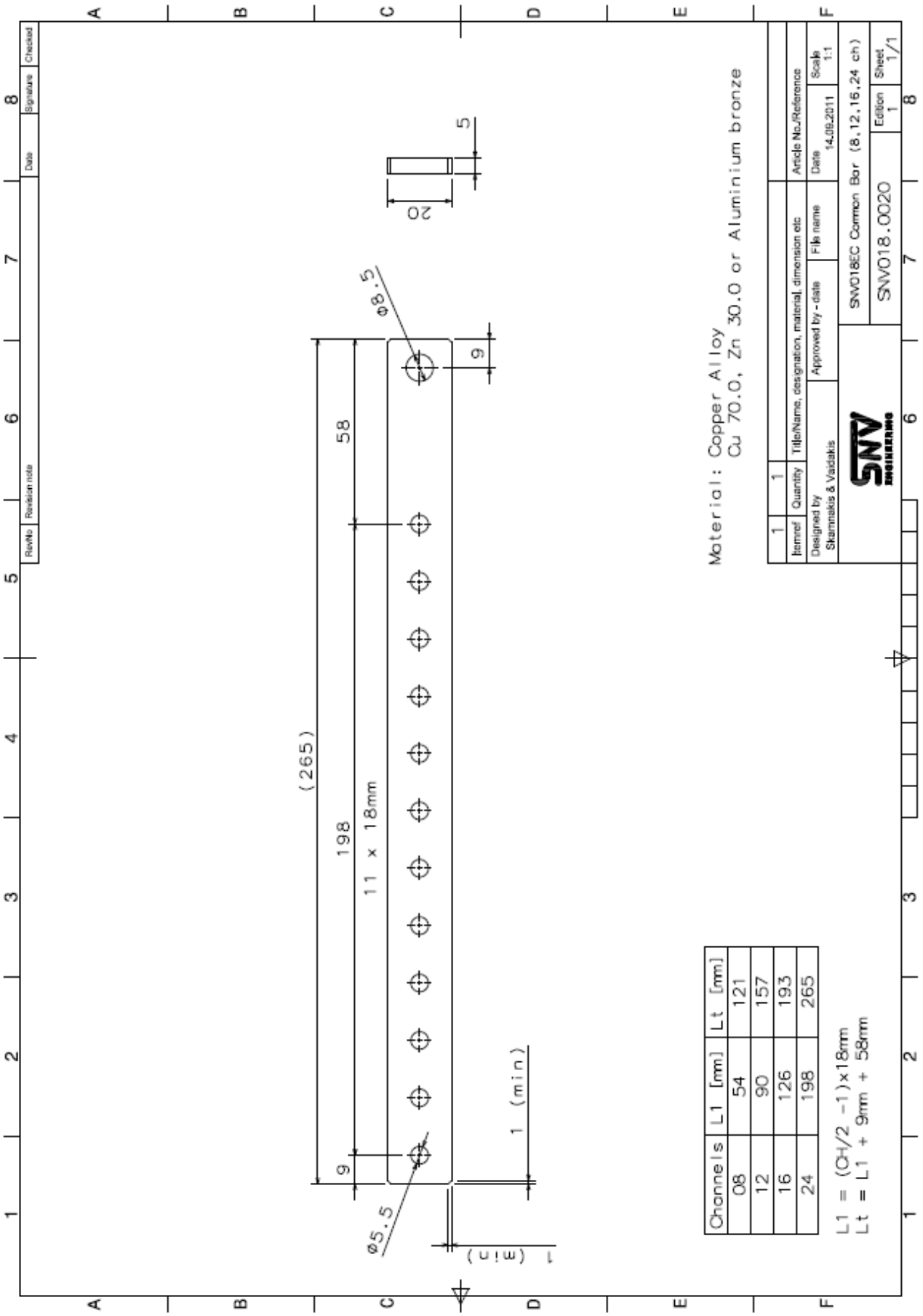
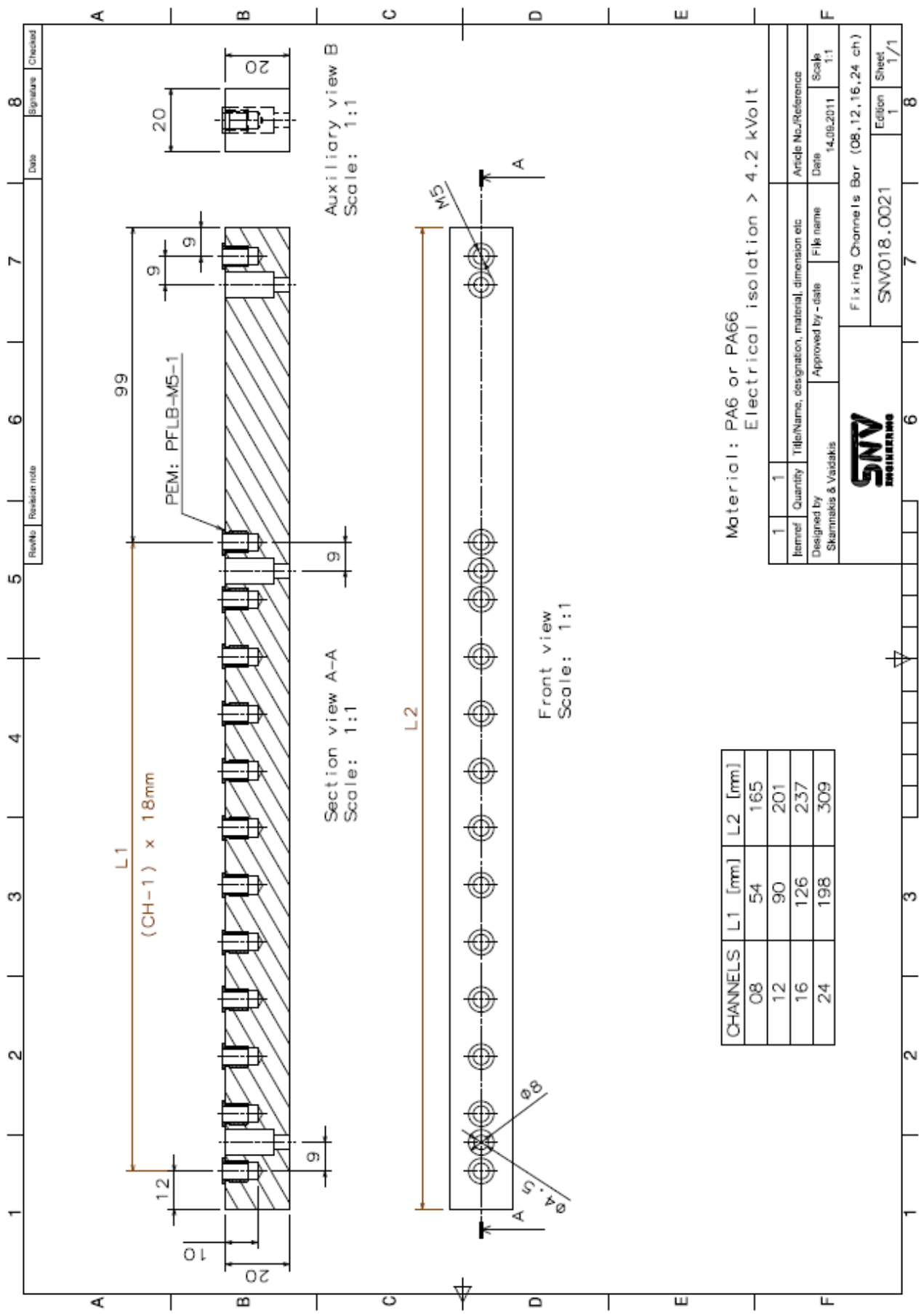
Annex A – Drawings

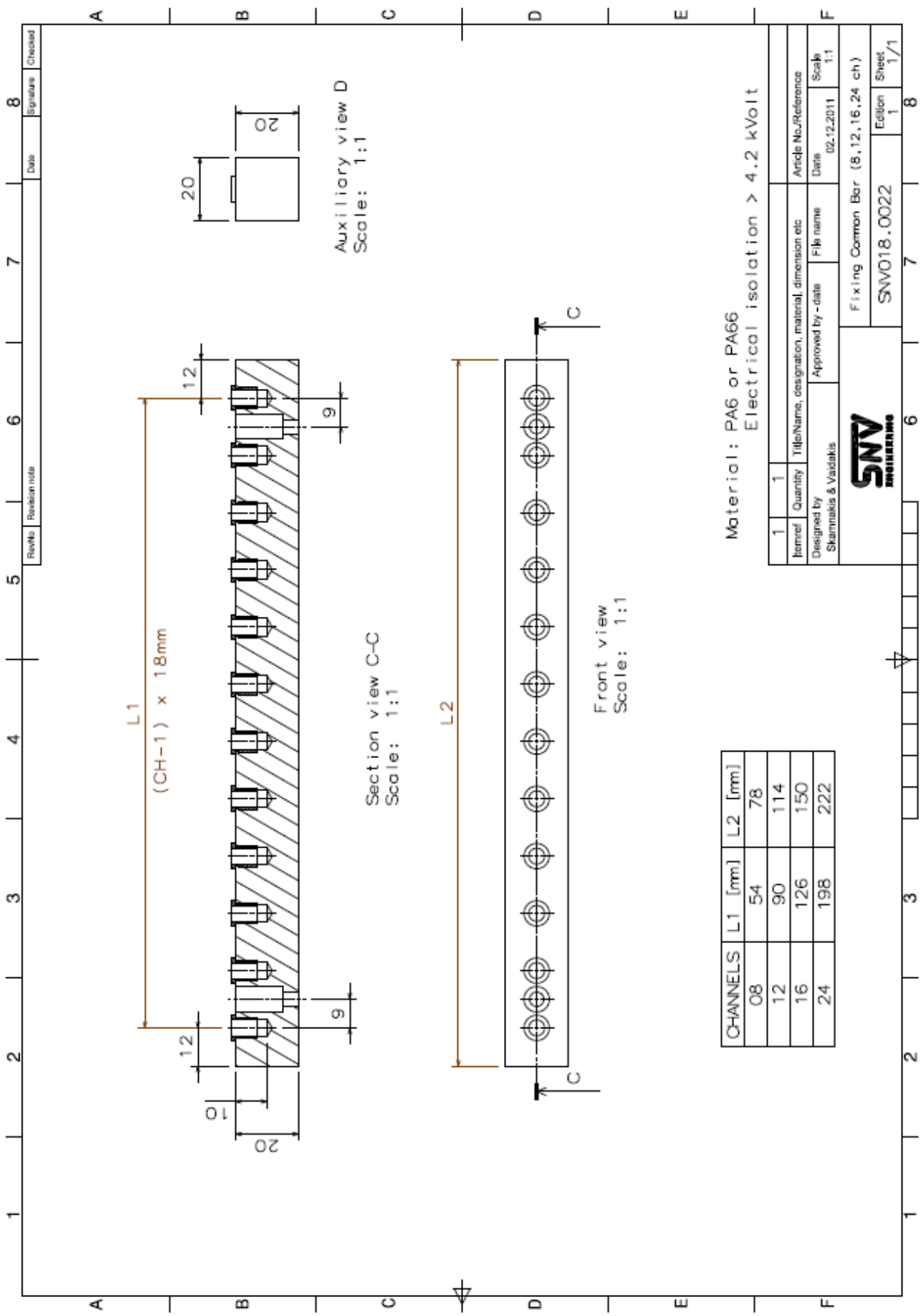
List of drawings:

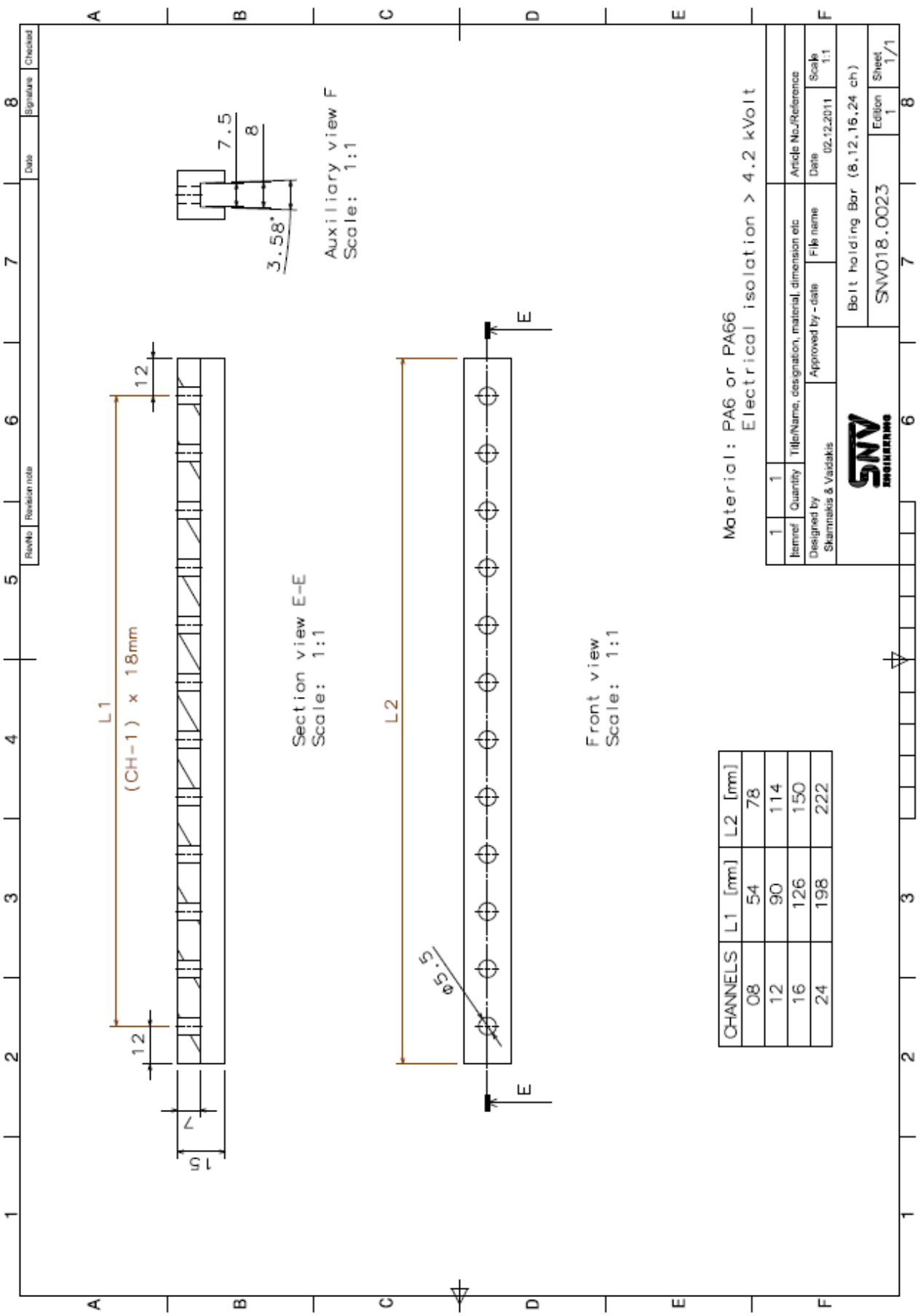
No	Reference No	Description
1	SNV018EC.0001	SNV018EC.XX – Board general dimensions
2	SNV018.0020	SNV018EC.XX – Common Bar
3	SNV018.0021	SNV018EC.XX – Mounting Current Bar
4	SNV018.0022	SNV018EC.XX – Mounting Common Bar
5	SNV018.0023	SNV018EC.XX – Bolt holding bar











Annex B – Bus Termination and Bias Resistors

The CMC cards are communicating using RS-485 bus. Termination resistors are required at the ends of the RS-485 transmission line in order to match the impedance of an end node (as a card) to the impedance of the transmission line. When impedance is mismatched, the signal transmitted is not completely absorbed, and a portion is reflected back into the transmission line.

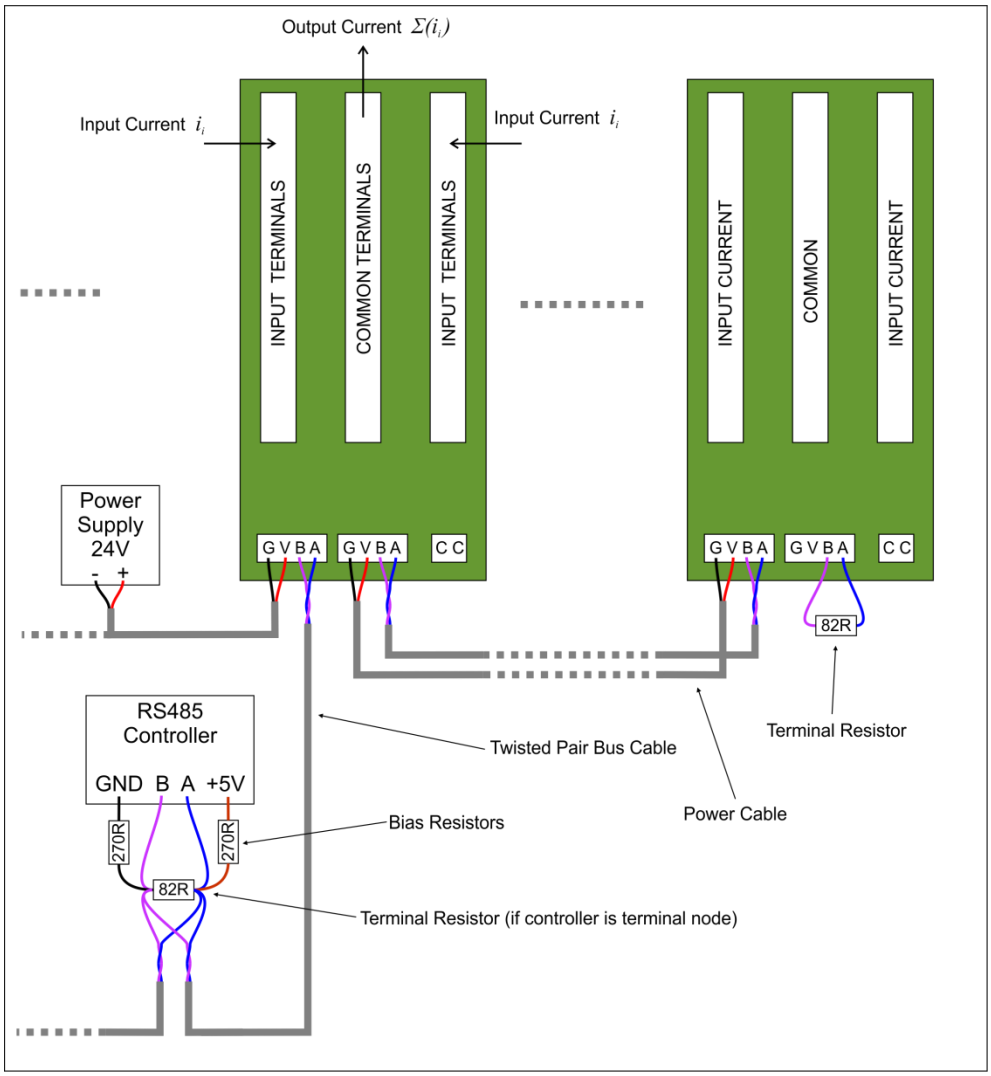


Figure 14: General Bus connection diagram.

When the RS-485 network is in an idle state, all nodes are in receive mode and transmition line is not driven. External noise could drive the line instead making

proper transmition not possible. Fail-safe biasing is used to keep the receiver's output in a defined state when in idle state, avoiding any noise interaction. Bias resistors consist of a pull-up resistor on the non-inverting line A and a pull-down on the inverting line B, maintaining a voltage difference between them greater than 200mV (in order to have a defined state). These resistors should be calculated depending the terminal resistors, and placed on the transmission line as illustrated in figure 15 (for "line topology" having two terminal resistors).

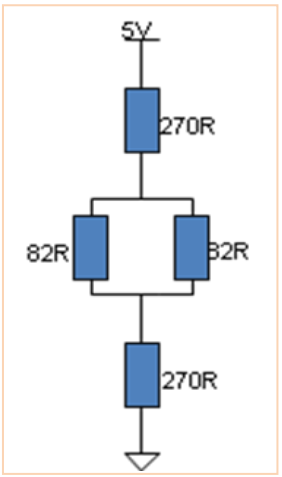


Figure 15: Bus termination and Bias resistors

Resistors is suggested to be metal film >= 0.5W.

For example using cable RE-2Y(St)Yv 04X2X0.5, 2 terminal resistors of 82 Ohm should be used at any transmission line end. And bias resistors of 270 Ohm when having two terminal resistors.