

## Current Measurement Card SNV012EC.B

### Features

- 8 isolated channels of dc current measurement (common low side)
- 0-11A or 0-13.4A measurement ranges (other ranges are available on demand)
- Very Low Sensing resistance on measurement channels: 5mΩ
- Measurement channels voltage up to 1000vdc
- 1kHz sampling per channel
- 1 digital input
- Board temperature measurement
- On board long time averaging and integrations
- Communication using MODBUS over RS485
- Board power consumption < 1W @ 24vdc
- Operating temperatures : -20°C to +60°C
- 32bit ARM CORTEX-M3 microcontroller @ 96MHz

### Description / Typical Applications

SNV012EC.B card is a DC current measurement & monitor card with an additional digital input. It is designed to be used in photovoltaic parks with central inverters in order to monitor string currents. It has 8 channels of DC current measurement. Low side terminal is common for the 8 channels, 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.

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. Averaged values of different cards are synchronized and bandwidth consumption on the bus is limited, giving the ability for a prompt response of the rest requests.

A digital input is also implemented in order to monitor other component like the condition of an SPD. Board temperature is also measured and provided.

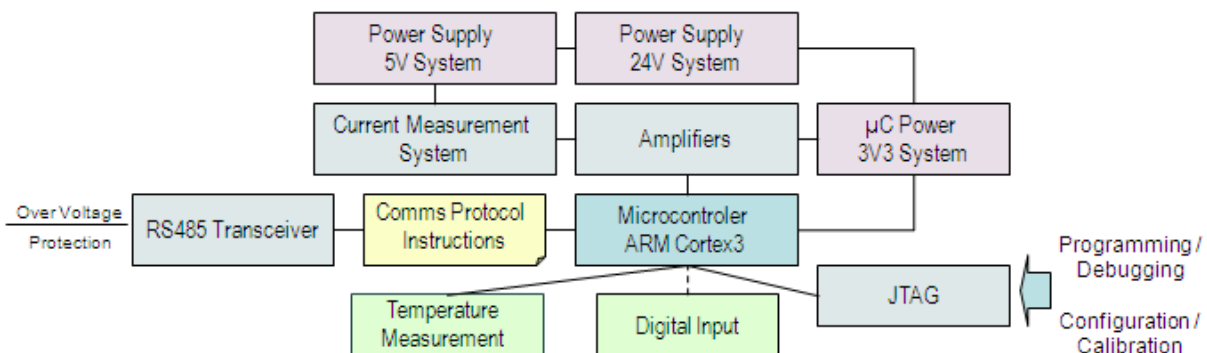


Figure 1: SNV012EC.B Block Diagram

## Characteristics

### Electrical

	<i>note</i>	<i>min</i>	<i>nominal</i>	<i>max</i>	<i>Unit</i>
Power supply	+/-20%	20	24	25	V dc
Consumption at 24V DC	Note 1 Note 2	30		35	mA
Measurement channel resistance	each			8	mOhm
Channel maximum current		-18		18	A
Channel max working voltage	Note 3			1000	V dc
Current measurement range		0	-	11	A

Note 1: The value is for each installed board

Note 2: The maximum number of cards to be installed in series is 247.

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

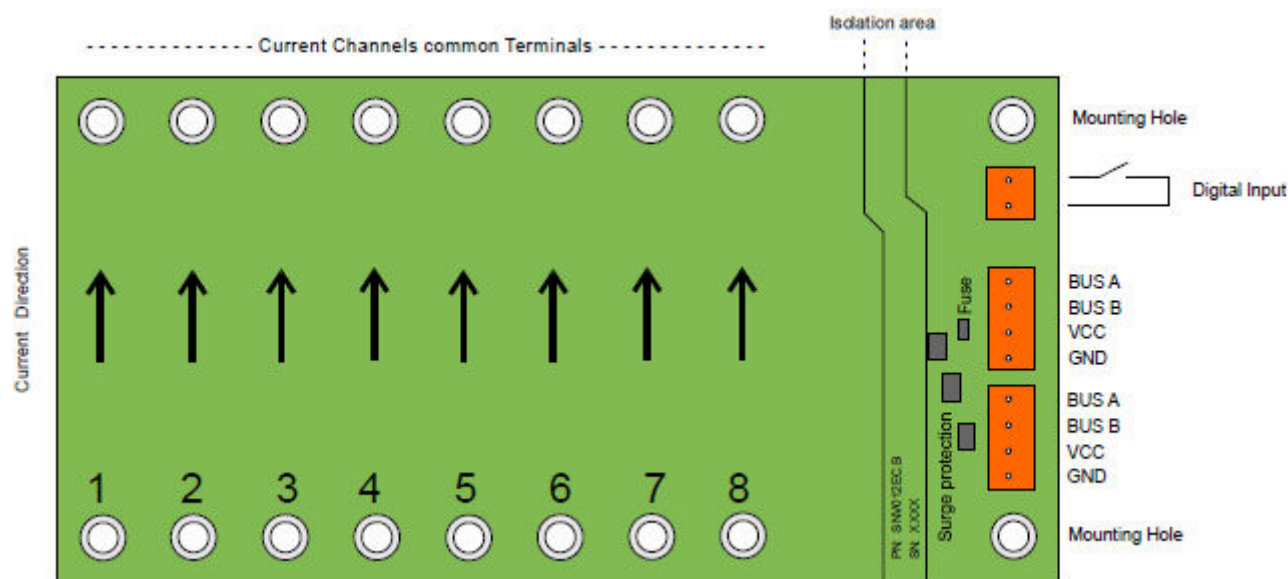
### Physical & Environmental Characteristics

	<i>Details</i>
Operating Temperature	-20 °C to +60 °C
Storage Temperature	-40 °C to +100 °C
Operating Altitude	600 ft
Non Operating Altitude	25000 ft
PCB Outline Dimensions	<i>See mechanical Specifications</i>
Board Dimensions	<i>See mechanical Specifications</i>
EMC	Meets EN 61326-1
Safety	Meets EN 61010-1
Measurement Category	RATED CLASS I and RATED TRANSIENT OVERVOLTAGES 1,5KV
Usage	External Use installed in a metallic box(and/or plastic), IP54

### Measurement Characteristics

Calibration current	at 6.4 A
Measurement Accuracy	±1.16% of measurement current
Thermal Drift	0.02 % / °C (see diagram 1)

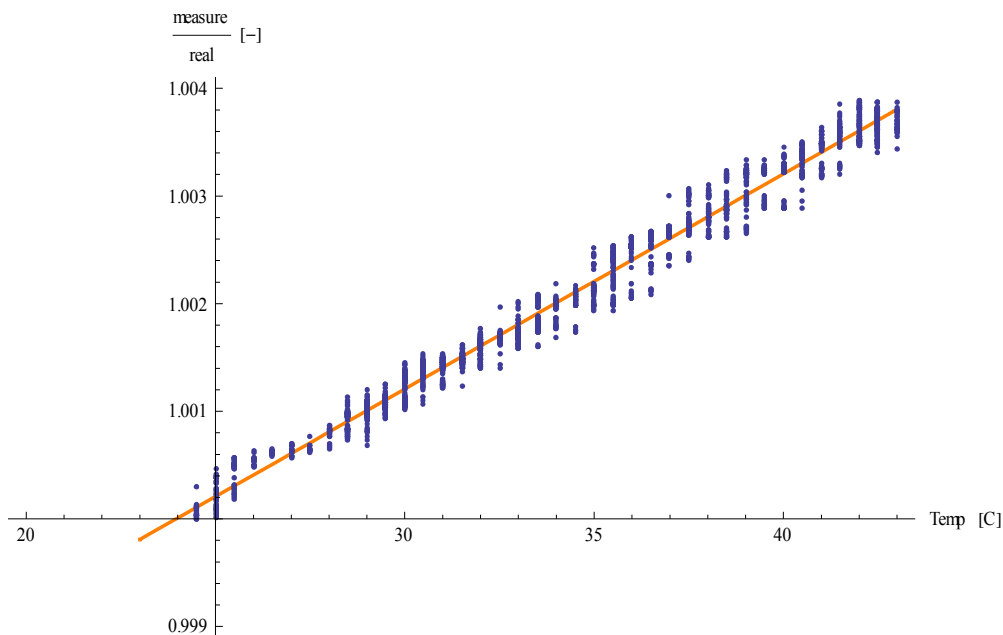
### Board Layout



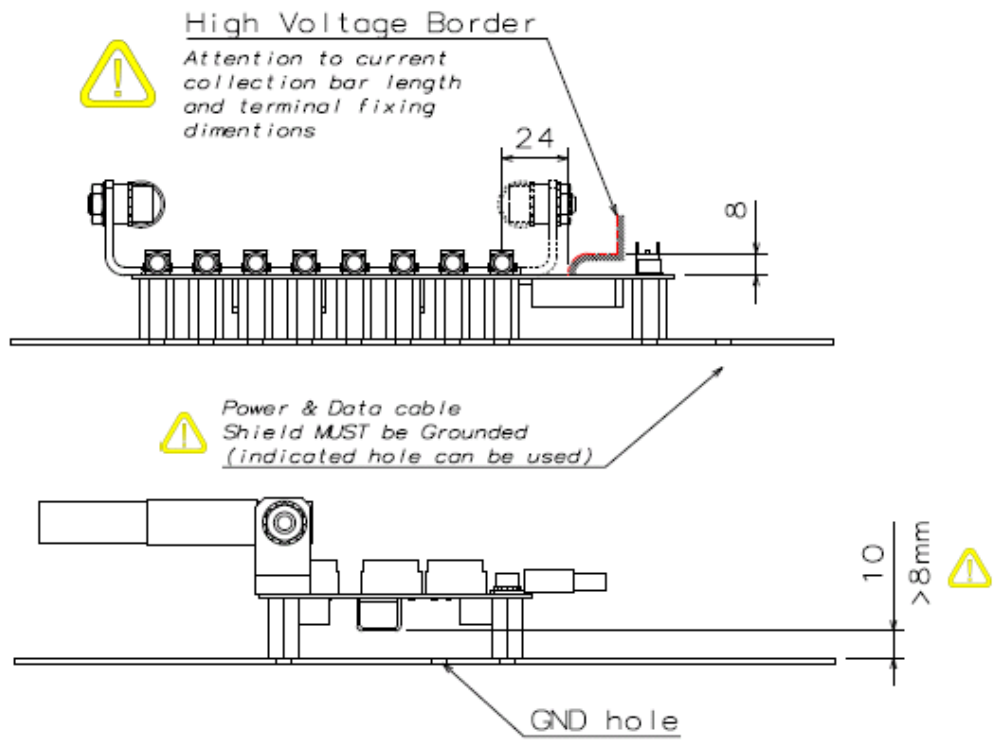
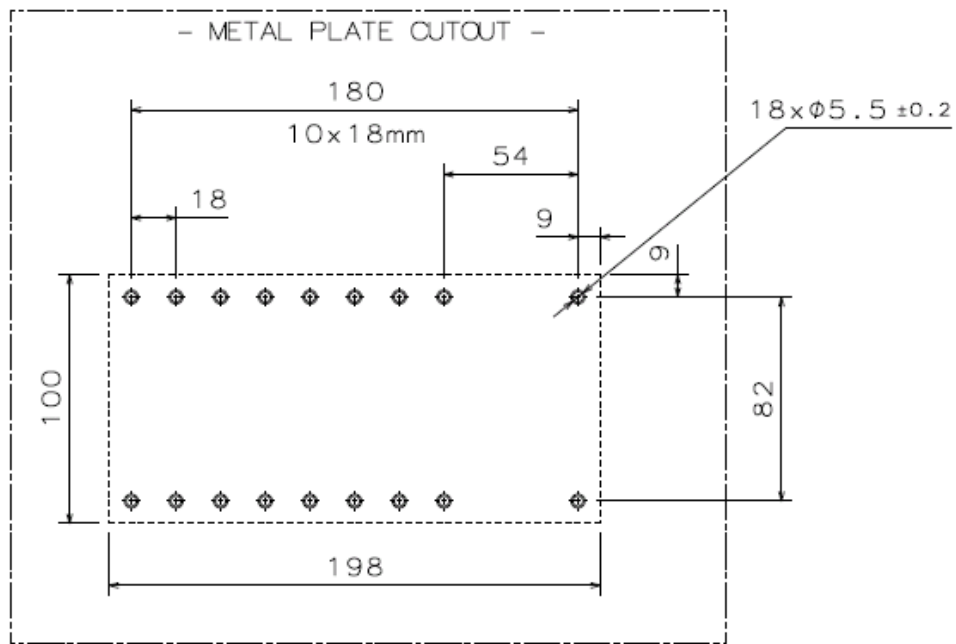
Input Current Channels 1 to 8

Figure 2: SNV012EC.B Board Layout

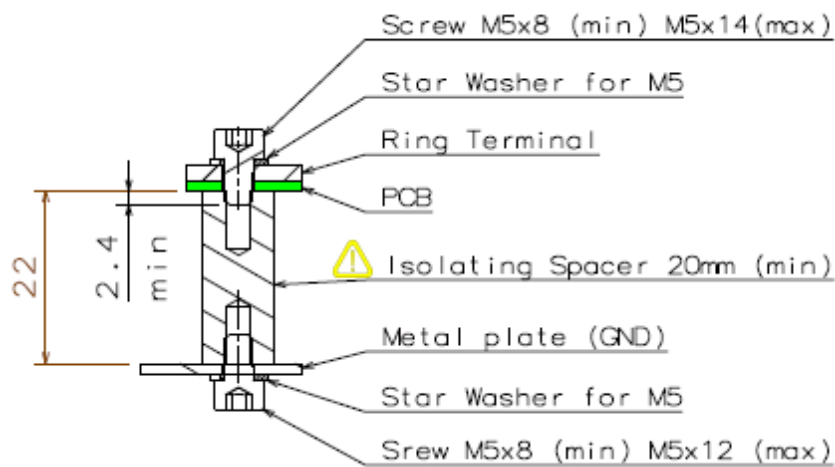
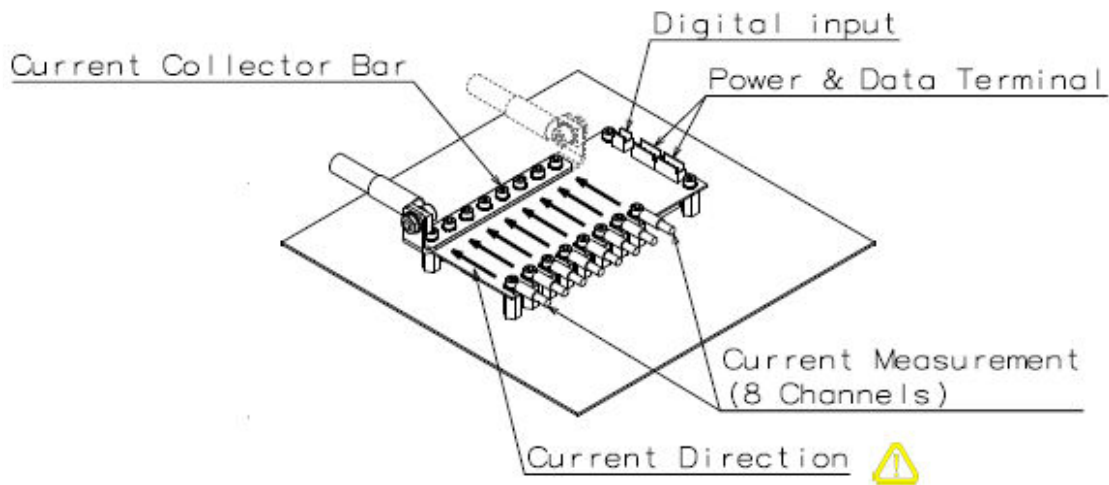
### Performance Characteristics



### Mechanical Specifications



Mechanical Specifications (continued)



### Serial Communication

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 Connection Topology

Current Measurement Cards SNV012EC.B can be connected in a bus topology (MODBUS over RS585). Up to Eight input current channels from a string of PV channels can be allocated to each card, the output current channel is available for connection to central inverter subsystem. Wire-to-Board connectors CON12 and CON34 are used to connect the cards to the bus as illustrated in the following diagram. Connector CON6 is used for surge arresting sensing

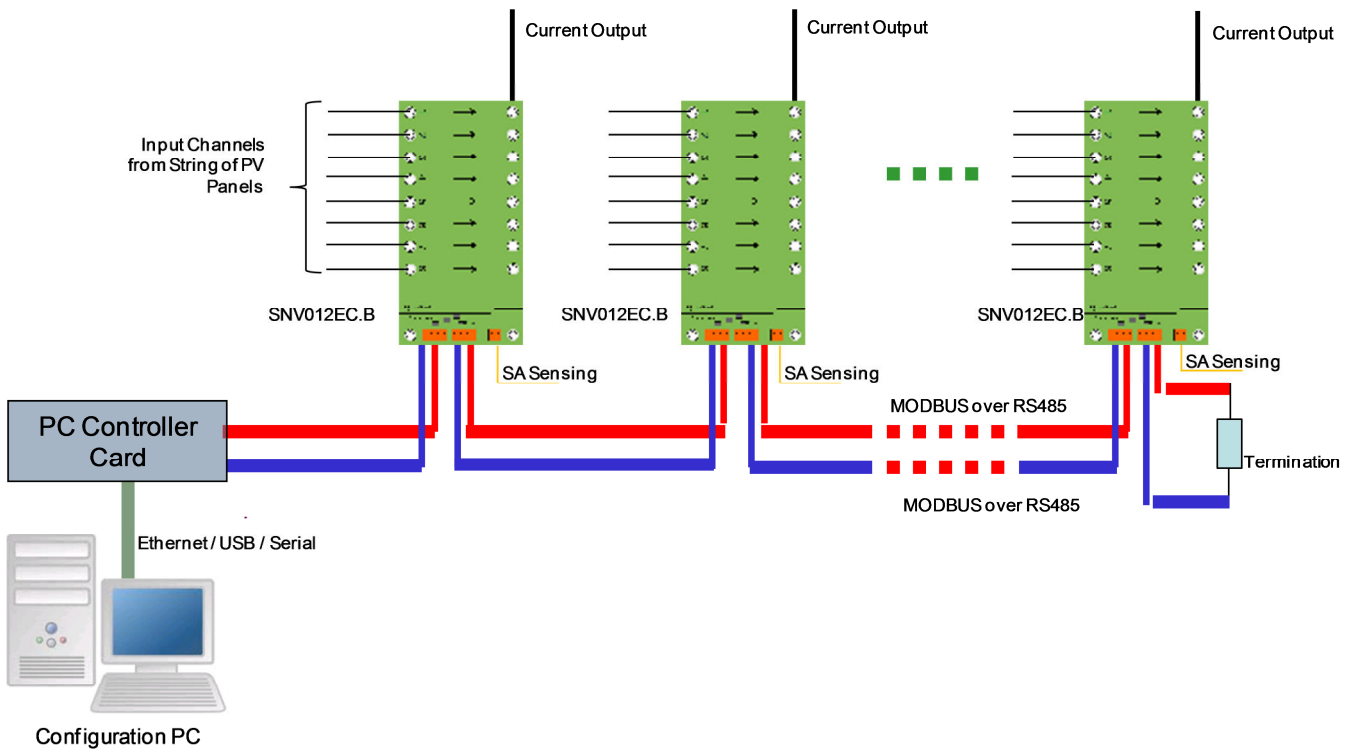


Figure 3: MODBUS Connection Topology

## MODBUS Memory Map

SNV012EC.B - 16bit input registers (modbus function 4)					
Address		Type	Units	Channel	Description
dec	hex				
0	0x 00	float	Amperes (A)	CH1	instant current
1	0x 01	(32bit)			
2	0x 02	float	Amperes (A)	CH2	
3	0x 03	(32bit)			
4	0x 04	float	Amperes (A)	CH3	
5	0x 05	(32bit)			
6	0x 06	float	Amperes (A)	CH4	
7	0x 07	(32bit)			
8	0x 08	float	Amperes (A)	CH5	
9	0x 09	(32bit)			
10	0x 0A	float	Amperes (A)	CH6	
11	0x 0B	(32bit)			
12	0x 0C	float	Amperes (A)	CH7	
13	0x 0D	(32bit)			
14	0x 0E	float	Amperes (A)	CH8	
15	0x 0F	(32bit)			
16	0x 10	float	Amperes (A)	CH1	current averaged
17	0x 11	(32bit)			
18	0x 12	float	Amperes (A)	CH2	
19	0x 13	(32bit)			
20	0x 14	float	Amperes (A)	CH3	
21	0x 15	(32bit)			
22	0x 16	float	Amperes (A)	CH4	
23	0x 17	(32bit)			
24	0x 18	float	Amperes (A)	CH5	
25	0x 19	(32bit)			
26	0x 1A	float	Amperes (A)	CH6	
27	0x 1B	(32bit)			
28	0x 1C	float	Amperes (A)	CH7	
29	0x 1D	(32bit)			
30	0x 1E	float	Amperes (A)	CH8	
31	0x 1F	(32bit)			

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32	0x 20	float	Amperes (A)	CH1	current squared averaged
33	0x 21	(32bit)			
34	0x 22	float	Amperes (A)	CH2	
35	0x 23	(32bit)			
36	0x 24	float	Amperes (A)	CH3	
37	0x 25	(32bit)			
38	0x 26	float	Amperes (A)	CH4	
39	0x 27	(32bit)			
40	0x 28	float	Amperes (A)	CH5	
41	0x 29	(32bit)			
42	0x 2A	float	Amperes (A)	CH6	
43	0x 2B	(32bit)			
44	0x 2C	float	Amperes (A)	CH7	
45	0x 2D	(32bit)			
46	0x 2E	float	Amperes (A)	CH8	
47	0x 2F	(32bit)			
48	0x 30	float	Amperes (A)	CH1	current holded values (Snapshot)
49	0x 31	(32bit)			
50	0x 32	float	Amperes (A)	CH2	
51	0x 33	(32bit)			
52	0x 34	float	Amperes (A)	CH3	
53	0x 35	(32bit)			
54	0x 36	float	Amperes (A)	CH4	
55	0x 37	(32bit)			
56	0x 38	float	Amperes (A)	CH5	
57	0x 39	(32bit)			
58	0x 3A	float	Amperes (A)	CH6	
59	0x 3B	(32bit)			
60	0x 3C	float	Amperes (A)	CH7	
61	0x 3D	(32bit)			
62	0x 3E	float	Amperes (A)	CH8	
63	0x 3F	(32bit)			
64	0x 40	float	Celsius (°C)	-	temperature
65	0x 41	(32bit)			



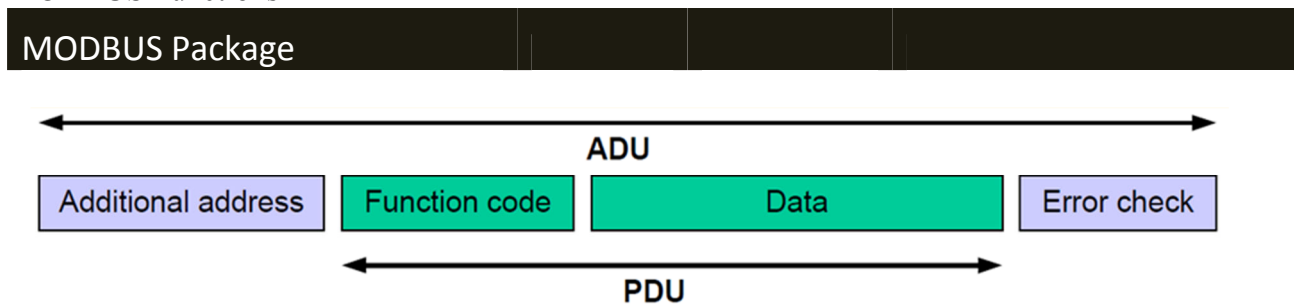
## SNV012EC.B - Coils – digital input (modbus function 1)

Address		Type	Description
dec	hex		
0	0x 00	LSB (bit)	digital input

## SNV012EC.B – Holding registers (modbus function code 10)

Address		Type	Description
dec	hex		
0	0x 00	Hi byte Lo byte	Comands: "hold"(0x01) or "mark"(0x02) or "change address"(0x0A) if comand is "change address", then set new target address
1	0x 01	Hi byte Lo byte	if comand is "change address", then set new target address if comand is "change address", then set new target address

MODBUS Functions



SNV012EC.B - MODBUS Functions					
Function	SubFunction	Data	Length	Values	Description
<b>1 (0x01)</b>	-	<b>Read Coils</b>			
		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	-			Error in reading register

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

<b>4 (0x04)</b>	-				<b>Read Input Registers</b>
		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

<b>8 (0x08)</b>					<b>Diagnostics</b>
	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	-			Error in reading register

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

<b>16 (0x10)</b>		<b>Write Multiple registers</b>		
	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 - paragrah 6.12

<b>17 (0x11)</b>		<b>Report Slave ID (Serial Line only)</b>		
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 - paragrah 6.13

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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 - paragrah 6.14

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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
	RD	=N x 2 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
	RRD	=N x 2 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 - paragrah 6.15

<b>43 (0x2B)</b>				<b>Encapsulated Interface Transport</b>	
	x0E			0x01 to 0x04	Read Device ID code
				0x00 to 0xFF	Object Id
<b>Response:</b>					
0x2B	x0E	RDID	1 Byte	0x01 to 0x04	Read Device ID code
			1 Byte	0x01 to 0x03	Conformity level
			1 Byte	0x81 to 0x83	More Follows
			1 Byte	0x00 or 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
<b>Error Report:</b>					
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 - paragrah 6.21