ComAp
The heart of smart control

Inteli DC4/4

Module for DC low voltage measurement and current measurement

HW version 1.0.0

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Global Guide

1 General information

This manual contains important instructions for Inteli DC4/4 module.

1.1 Clarification of Notation

Note: *This type of paragraph calls the reader's attention to a notice or related theme.*

> **IMPORTANT: This type of paragraph highlights a procedure, adjustment etc., which can cause a damage or improper function of the equipment if not performed correctly and may not be clear at first sight.**

> **WARNING: This type of paragraph highlights a procedure, adjustment etc., which can cause a damage or improper function of the equipment if not performed correctly and may not be clear at first sight.**

> **Example:** This type of paragraph contains information that is used to illustrate how a specific function works.

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General security recommendations and set of measures

1. Production mode
   - Disable production mode BEFORE the controller is put into regular operation.
2. User accounts
   - Change password for the existing default administrator account or replace that account with a completely new one BEFORE the controller is put into regular operation mode.
   - Do not leave PC tools (e.g. InteliConfig) unattended while a user, especially administrator, is logged in.
3. AirGate Key
   - Change the AirGate Key BEFORE the device is connected to the network.
   - Use a secure AirGate Key – preferably a random string of 8 characters containing lowercase, uppercase letters and digits.
   - Use a different AirGate Key for each device.
4. MODBUS/TCP
   - The MODBUS/TCP protocol (port TCP/502) is an instrumentation protocol designed to exchange data between locally connected devices like sensors, I/O modules, controllers etc. By it's nature it does not contain any kind of security – neither encryption nor authentication. Thus it is intended to be used only in closed private network infrastructures.
   - Avoid using MODBUS/TCP in unprotected networks (e.g. Internet).
5. SNMP
   - The SNMP protocol (port UDP/161) version 1 and version 2 are not encrypted. They are intended to be used only in closed private network infrastructures.
   - Avoid using SNMP v1 and v2 in unprotected networks (e.g. Internet).

Document history

Revision number	Related sw. version	Date	Note	Author
3	1.0.0	25.03.2024		ComAp
2	1.0.0	29.02.2024	Product sticker changed (UL)	ComAp
1	1.0.0	1.08.2023		ComAp

2 Description

Inteli DC 4/4 module is an extension module, transducer type, equipped with analog inputs and analog outputs. The module can be used with various types of controllers, purposed for applications where we need to measure precisely direct voltage and direct current (DC Voltage, DC Current)

3 Available Inputs / Outputs

Analog Inputs

- 4 channels – 2 for Voltage and 2 for Current measurement
  - Voltage measurement input up to 1500 VDC – direct measurement
  - Current measurement with external shunt up to 3000 ADC (100 mV max voltage input from external shunt resistor)

Analog Outputs

- 4 channels - 2 for Voltage and 2 for Current measurement
  - 4 .. 20 mA current loop output (see the transfer function section)

4 Device installation

The I-DC4/4 module should be installed on a DIN rail inside a cabinet.

Note: *Unit is 35 mm DIN rail mounted.*

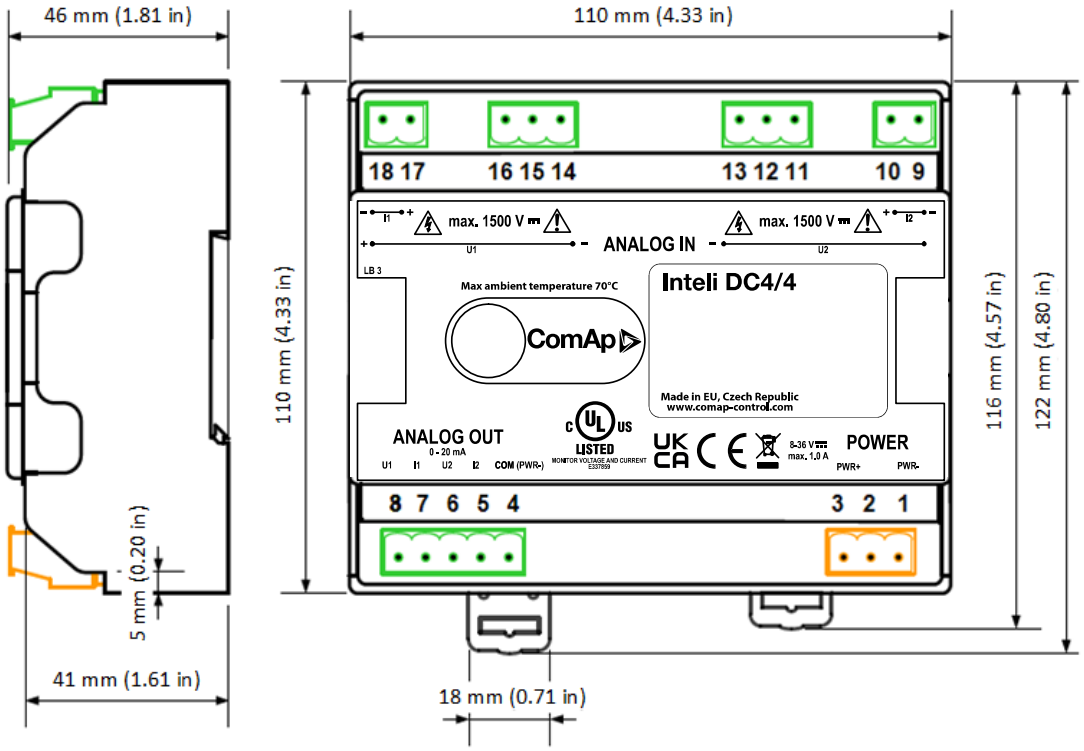


Image 5.1 Dimensions

A DIN rail is a common and reliable option for installing the I/O modules along with other associated devices. Efficient ventilation is achieved with the cabinet wall-mounted DIN rail and with adequate space provided between the module rail and adjacent rails or other devices.

The module is typically installed vertically in cabinet (on a DIN rail going from left to right), with the device label text in the upright position reading left to right.

5 Device operation/manipulation

The product can only be operated if additional protection against electric shock is provided in the installation, corresponding to the measured voltage and specific application conditions. Hazardous live parts include measuring terminals **U1, U2, I1, I2, and the entire area marked in red** on the product:

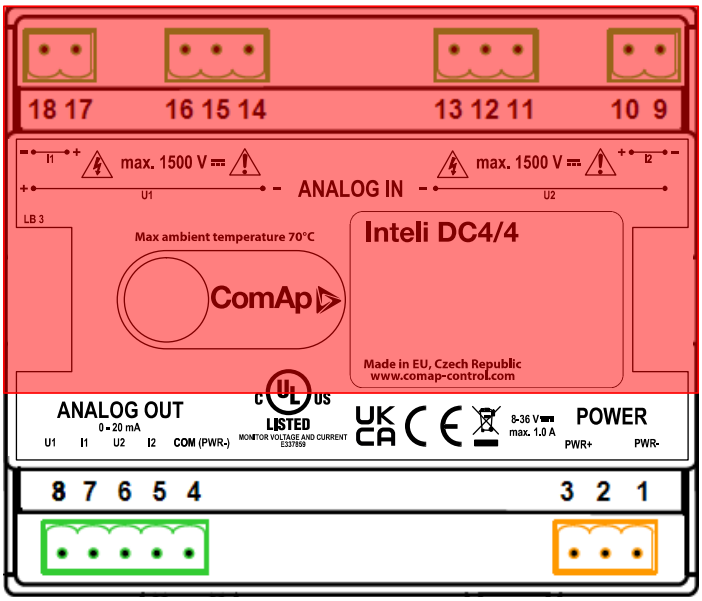


Image 6.1 Hazardous live parts on the device

WARNING: The voltage at hazardous live part (measuring terminals U1, U2, I1, I2) shall be disconnected before any manipulation with the product.

6 Configuration in InteliConfig

Inteli DC 4/4 module serves as an analog to analog transducer for direct voltage and current measurements. Analog outputs (0-20mA) from I-DC 4/4 module are connected to Analog inputs of the controller.

Default configuration in InteliConfig

Controller Configuration → I/O Configuration → Analog Inputs

Controller	AIN1	DC Source Current Meas	DC Source Current Meas	DC Current Measurement	A	0-20mA passive
Controller	AIN2	DC Energy Source Voltage Meas	DC Energy Source Voltage Meas	DC Voltage Measurement	V	0-20mA passive
Controller	AIN3	DC Source Voltage Meas	DC Source Voltage Meas	DC Voltage Measurement	V	0-20mA passive

Image 7.1 Default configuration in InteliConfig

Default sensor configuration

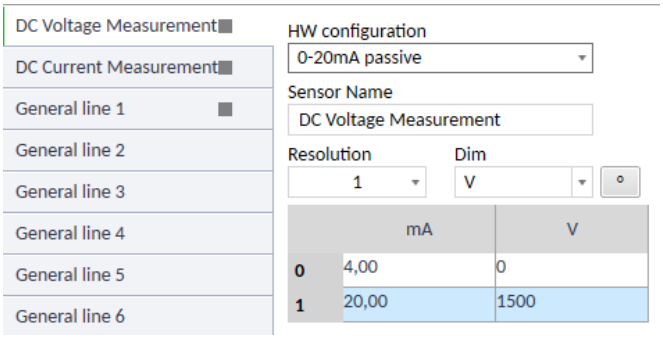


Image 7.2 Default sensor configuration

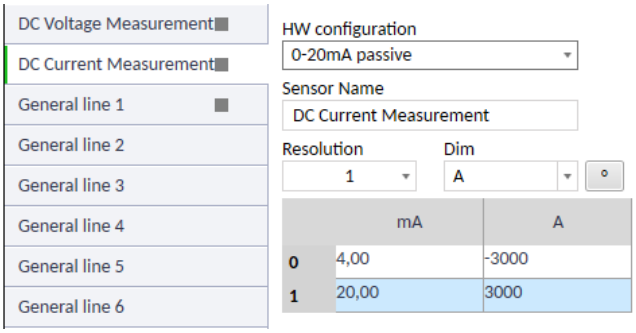


Image 7.3 Default sensor configuration

Value -3000A / 3000A correspond with shunt resistor nominal current and is included in shunt resistor datasheet as well as the shunt resistor output voltage (in mV).

To ensure the I-DC 4/4 module measures correctly, some correction/calibration factors have to be implemented by re-calculation of limit values by using following formulas:

DC Current

$$I_{I\#}[\mathrm{mA}] = 0,076141 \times U_{SHUNT\#}[\mathrm{mV}] + 12,032516$$

DC Voltage

$$I_{U\#}[\,\mathrm{mA}] = 0,013682 \times U_{BUS\#}[\mathrm{V}] - 0,042213$$

Example for 100A/75mV Shunt resistor:

By filling shunt resistor data from datasheet (nominal current, output voltage) and required voltage measuring range, corresponding values of output currents are calculated.

Shunt Resistor

Nominal current	100	A	from Shunt Datasheet
Nominal Output voltage +	75	mV	from Shunt Datasheet
Nominal Output voltage -	-75	mV	

formula:

$$I_{I\#}[\mathrm{mA}] = 0,076141 \times U_{SHUNT\#}[\mathrm{mV}] + 12,032516$$

DC module

Nominal output current	17.74	mA	
	6.32	mA	
Maximal DC voltage	800	VDC	required maximal DC voltage to be measured
	10	VDC	required minimal DC voltage to be measured
Corresponding Output current	10.90	mA	formula:
	0.09	mA	

$$I_{U\#}[\mathrm{mA}] = 0,013682 \times U_{BUS\#}[\mathrm{V}] - 0,042213$$

Image 7.4 Calculated corresponding values

The calculated values / operating points are then configured in InteliConfig

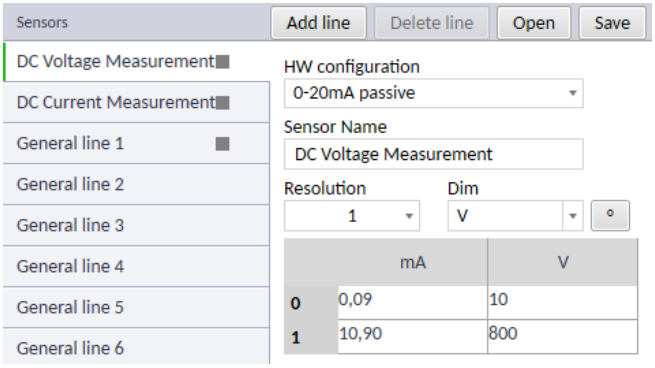


Image 7.5 Configuration of calculated values / operating points

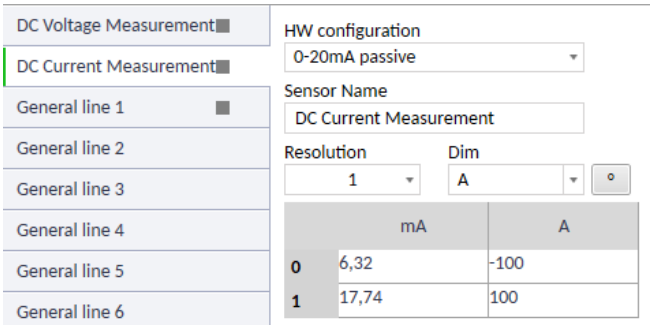


Image 7.6 Configuration of calculated values / operating points

7 Connectors

Analog inputs have 2-pin and 3-pin connector for safe connection of DC Voltage (up to 1500 VDC) with common “+” pole for mV input for shunt voltage (current measurement).

Analog outputs have 5-pin connector with common “COM” and 4 mA outputs.

Power supply is by 3-pin connector.

8 Supported sensors

- **Voltage measurement**
  - No sensors needed, direct DC voltage measurement (up to 1500 VDC)
- **Current measurement**
  - Shunt resistor with 60 mV output, up to 3000 A / 60 mV

9 Terminals and dimensions

Terminals

Terminal	Symbol	Description	Note
1	-	Power supply negative terminal	
2		Not connected	Do not connect
3	+	Power supply positive terminal	
4	COM	Analog output common terminal	Reference point for analog outputs, internally connected to Terminal 1.
5	I2	Analog output current, channel two	
6	U2	Analog output voltage, channel two	
7	I1	Analog output current, channel one	
8	U1	Analog output voltage, channel one	
9		Measurement input common, channel two	Current Sense (external shunt) negative terminal, Voltage sense positive terminal.
10		Measurement input current, channel two	Current Sense (external shunt) positive terminal.
11		Not connected	Do not connect
12		Not connected	Do not connect
13		Measurement input voltage, channel two	Voltage Sense negative terminal.
14		Measurement input voltage, channel one	Voltage Sense negative terminal.
15		Not connected	Do not connect
16		Not connected	Do not connect
17		Measurement input current, channel one	Current Sense (external shunt) positive terminal.
18		Measurement input common, channel one	Current Sense (external shunt) negative terminal, Voltage sense positive terminal.

Note: *Measurement category of live electrical circuits of measuring terminals U1, U2, I1, and I2 CAT III / 1000 VAC, 1500 VDC*

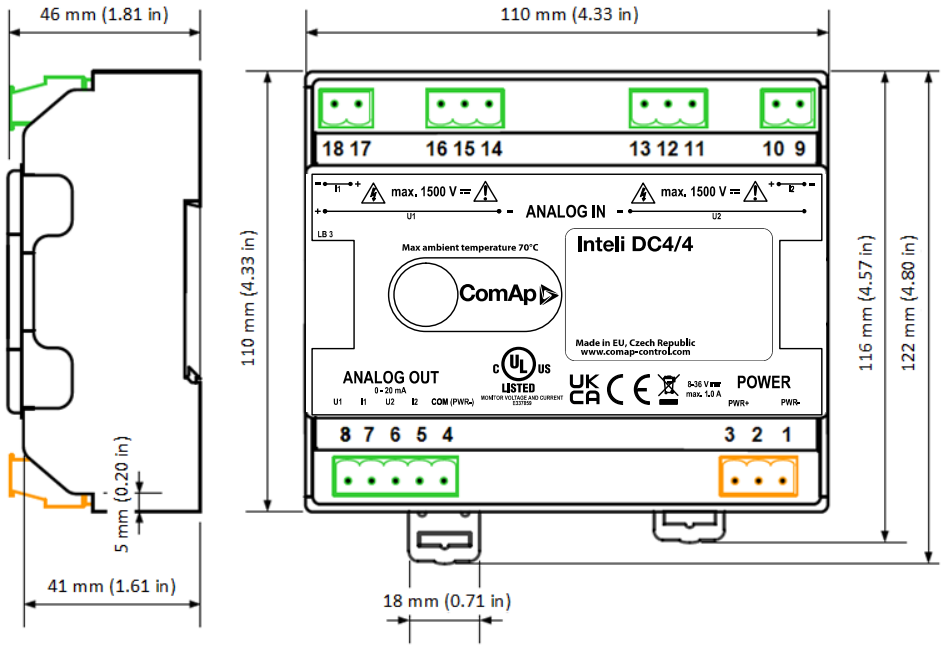


Image 10.1 Dimensions

Terminal rating

Terminals	Rating
1, 3	Nominal voltage between terminals: 36 V Nominal current: 0.5 A
4, 5, 6, 7	Nominal voltage between terminals: 15 V Nominal current: 20 mA
9, 10	Nominal voltage between terminals: 12 V Nominal current: 20 mA
9, 13	Nominal voltage between terminals: 1.5 kV Nominal current: 0.4 mA
10, 13	Nominal voltage between terminals: 1.5 kV Nominal current: 0.4 mA
14, 17	Nominal voltage between terminals: 1.5 kV Nominal current: 0.4 mA
14, 18	Nominal voltage between terminals: 1.5 kV Nominal current: 0.4 mA
17, 18	Nominal voltage between terminals: 12 V Nominal current: 20 mA

10 LED indication

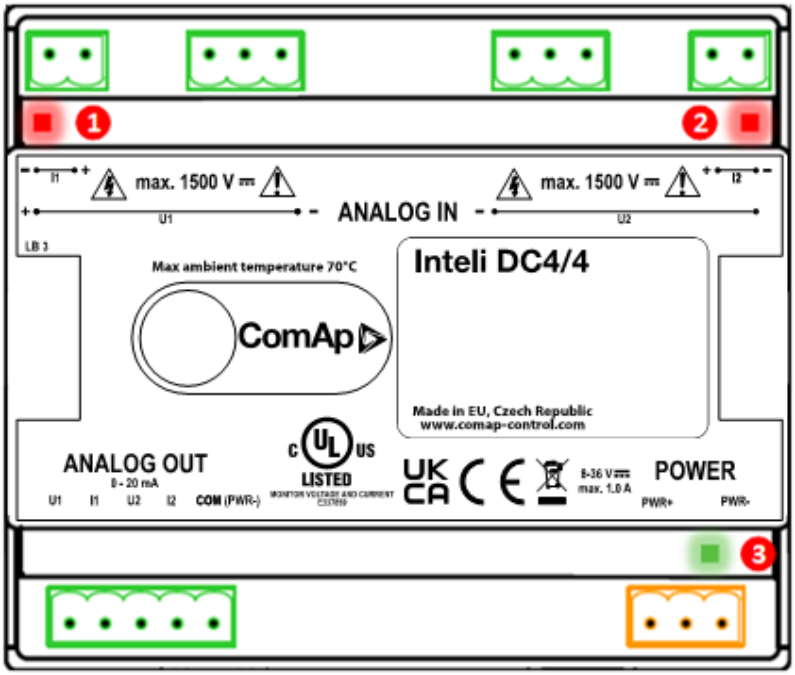


Image 11.1 Indication of LED lights

LED	Description
1	Indicates mode of current measurement. **Lit up**:* › Channel 1 is in mode of current measurement via external shunt with external amplifier. **Dark**:** › Channel 1 is in mode of current measurement via external shunt resistor.
2	Indicates mode of current measurement. **Lit up**:* › Channel 2 is in mode of current measurement via external shunt with external amplifier. **Dark**:** › Channel 2 is in mode of current measurement via external shunt resistor.
3	Power indication. **Lit up**: › Device is turned ON. **Dark**: › Device is turned OFF.
*** Lit up LED also indicates open terminals (9, 10 or 17, 18).** **** Dark LED also indicates shorted terminals (9, 10 or 17, 18).**	

11 Wiring

11.1 Measure: HV Bus Voltage and Current (SHUNT)

The module I-DC4/4 allows to measure high bus voltage and current. Wiring for such measurement is shown on **Image 11.2**. Current is measured via an external shunt resistor. Information of a measured values is provide via current loops. Transfer function for voltage and current measurement are in chapter **Transfer functions (page 19)**.

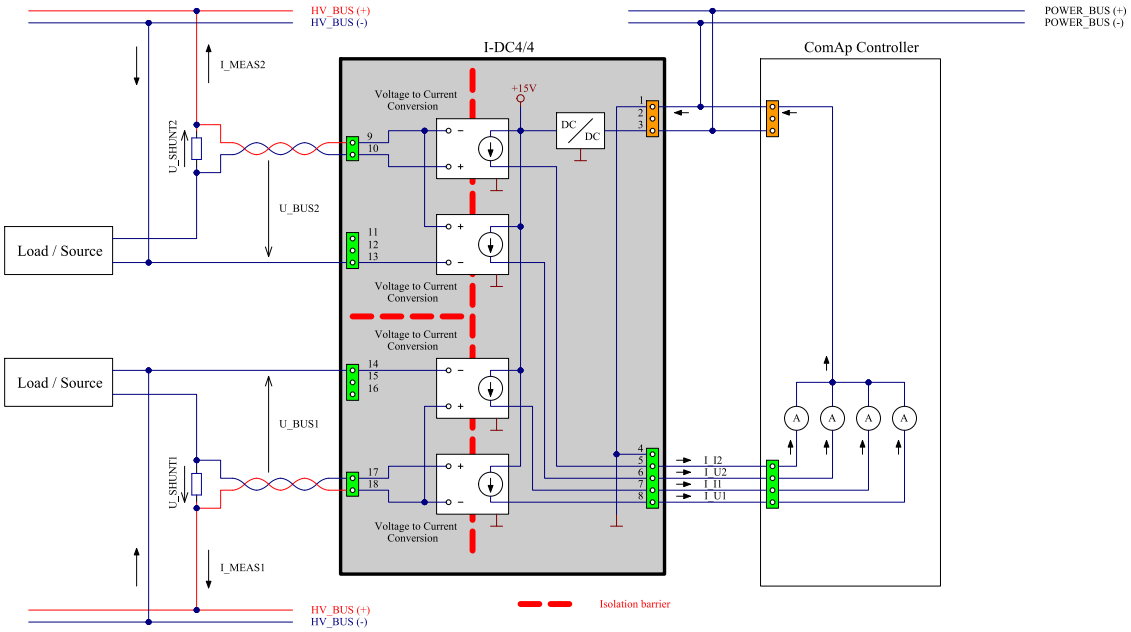


Image 11.2 SHUNT wiring scheme

The shunt resistor for current measurement should be connected in the positive pole of a HV bus. On the **Image 11.3** configuration is illustrated for current measurement via the external shunt resistor in the negative pole of the HV bus.

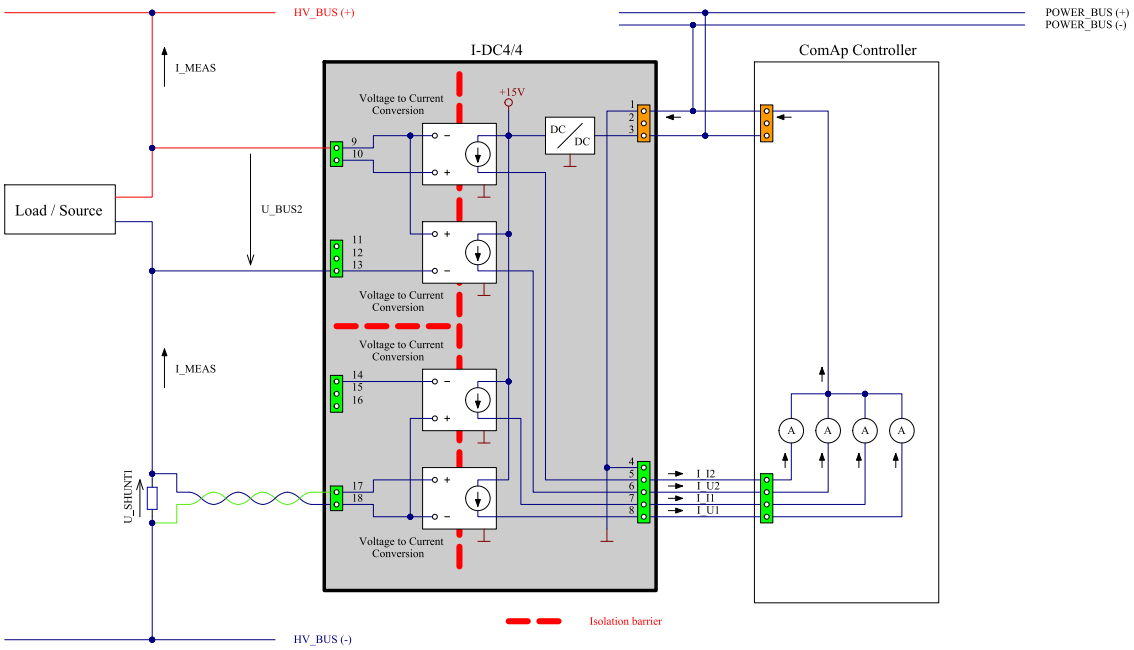


Image 11.3 SHUNT in negative branch

When current loops are read by a ComAp controller the negative power supply terminals of both the modul I-DC4/4 and the controller should be interconnected. This allows the return current to flow back to the module (closed current loop).

11.2 Isolated floating current loop measurement

When the current loops are measured by an isolated (floating) external unit the return current cannot flow back to the module via the negative power supply terminal. In such case the external unit must be connected to the terminal 4 (COM) so the current loops are properly closed, see **Image 11.4**.

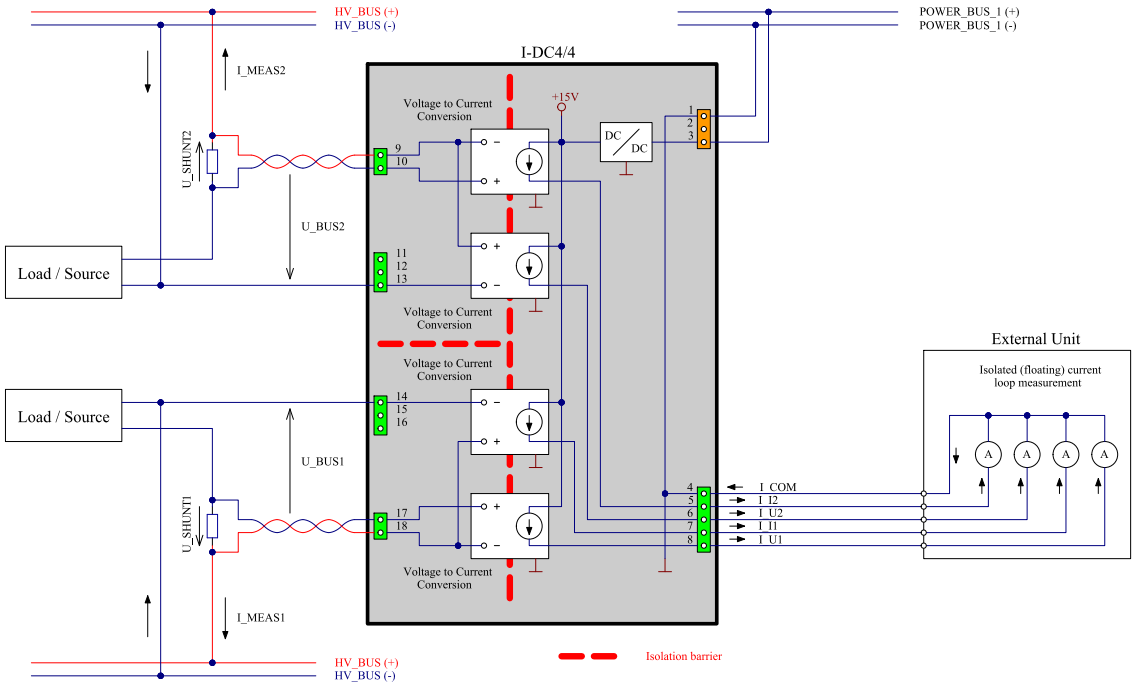
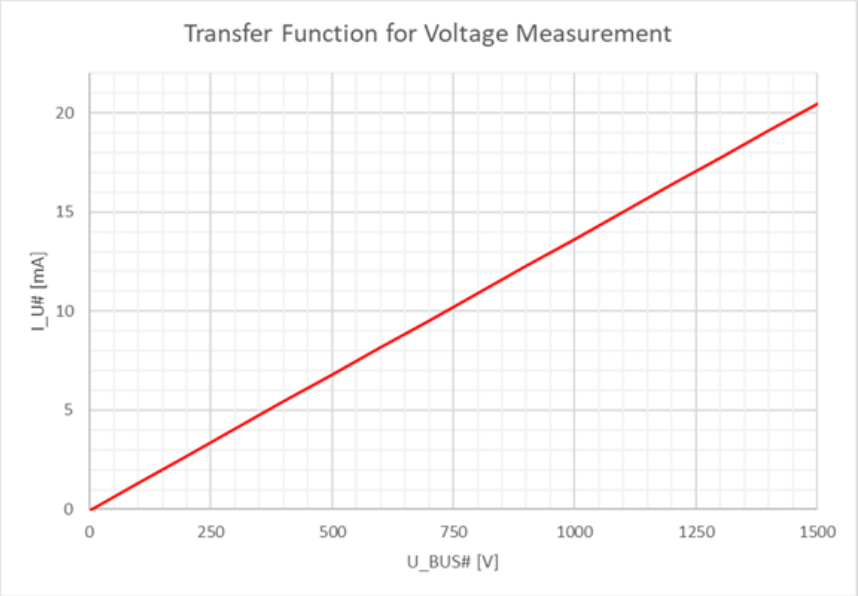


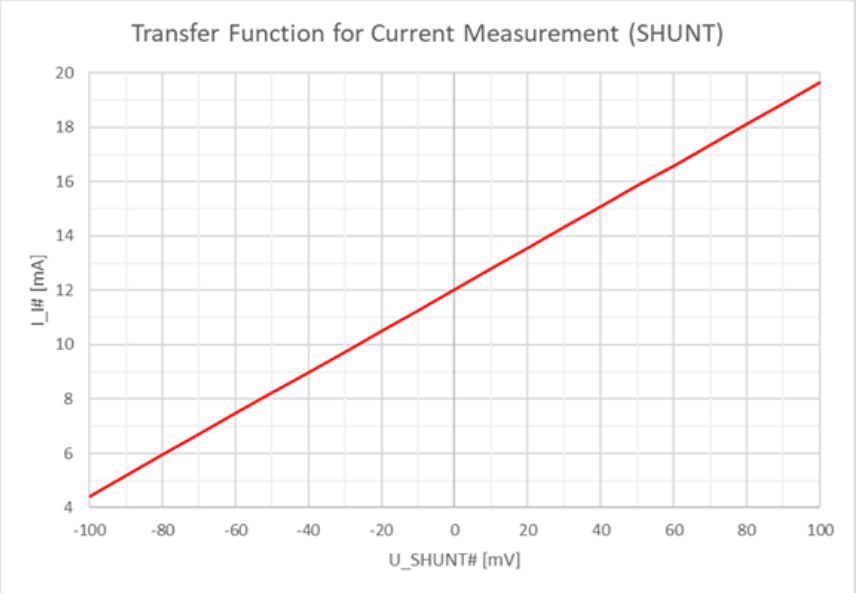
Image 11.4 Isolated floating current loop

12 Transfer functions



$$I_{U\#} = 0,0137 \cdot U_{BUS\ \#}\ [mA;\ V]$$

Image 12.1 Transfer function for voltage measurement



$$I_{I\#} = 0,076 \cdot U_{SHUNT\#} + 12,1\ [mA;\ mV]$$

Image 12.2 Transfer function for current measurement (SHUNT)

13 Technical data

General information

Dimensions	110 × 110 × 46 mm (4.3” × 4.3” × 1.8”)
Weight	250 g
Interface to controller	Analog

Power supply

Nominal power supply	24 V DC
Acceptable power supply range	8 .. 36 V DC
Nominal power consumption	3.8 W 160 mA @ 24 V DC
Max. Heat Dissipation	5 W

Operating conditions

Storage temperature	-40 ˚C .. +80 ˚C
Operating temperature (ambient)	-40 °C .. +70 °C
Operating humidity	max. 95 % non-condensing (EN 60068-2-30)
Protection degree	IP20, suitable for pollution degree 2
Vibration	5 .. 25 Hz, ± 1.6 mm 25 .. 100 Hz, a = 4 g
Shocks	max. 500 m/s^2
Altitude	max. 2000 m

DC Current measurement

Number of channels	2
Measurement type	Bipolar galvanically isolated
Measurement range (sense terminals)	± 100 mV measuring directly via external shunt resistor 4 .. 20 mA measuring via external shunt with external amplifier Max. measurement current depends on the shunt selection (up to ± 3 kA)
Accuracy	2% of the range

DC Voltage measurement

Number of channels	2
Measurement type	Unipolar galvanically isolated
Measurement range	direct measurement up to 1.5 kV DC
Accuracy	1% of the range
Input impedance	3.78 MΩ

Analog outputs

Number of channels	4
Type	Current loop (4 .. 20 mA)
Load	R.load < 500 Ω

Note: *For connecting the product, wires shall have insulation specified for temperatures corresponding to the maximum operating temperature with margin + 15°C.*

14 Application Notes

Following sections contains examples of measurement with the Inteli DC4/4.

14.1 High Voltage Measurement

Inteli DC4/4 module provides two channels for direct hight voltage measurement. According to **SHUNT wiring scheme (page 17)** measured voltage $U_{BUS\#}$ [V] is converted into current $I_{U\#}$ [mA]. Conversion is based on transfer function shown on Image 2.4.

Example: When the measured voltage U_{BUS1}=1000 V, the current I_{U1} is calculated as follows:

$$I_{U1} = 0,0137 \cdot U_{BUS1} = 13,7\ mA$$

14.2 Current Measurement (SHUNT)

Inteli DC4/4 module provides two channels for direct current measurement via external shunt resistor. According to **SHUNT wiring scheme (page 17)** voltage drop $U_{SHUNT\#}$ [mV] on the caused by the measured current $I_{MEAS\#}$ through shunt resistor is converted into current $I_{I\#}$ [mA]. Conversion is based on transfer function shown on **Image 11.2**.

Example: The measured current I_{MEAS1}=3000 A causes voltage drop U_{SHUNT1}=30 mV, when using shunt resistor 60 mV/6000 A. The current I_{I1} is calculated as follows:

$$I_{U1} = 0,076 \cdot U_{SHUNT1} + 12,1 = 14,38\ mA$$