

DC12

Current measurement system

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What can DC12 be used for

DC12 is designed for DC and AC current measurement in electric switchboards. The DC12 printed circuit board has 12 Hall effect current sensors. At the same time it has one voltage measurement input. Measured voltage is used to calculate electric power for each current channel.

The results are available on isolated serial communications port which follows the two wire RS485 signaling standard. The protocol is modbus RTU.

The DC12 board can be used in:

- telecom -48 VDC distribution network.
- in energy utilities and electric power stations to measure 110 VDC and 220 VDC power distribution.
- in solar power plants.

DC12 advantage:

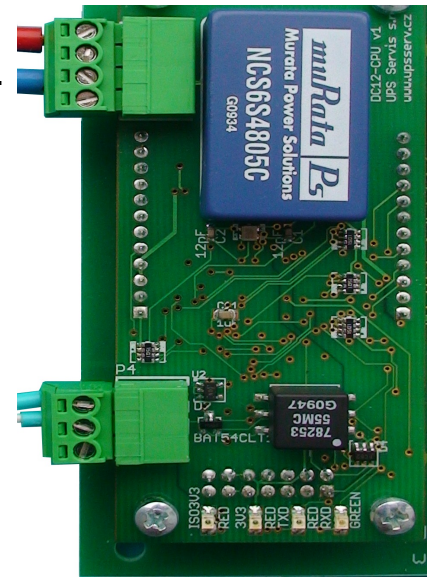
- High measurement density: more measurements in small place.
- Measures current in both directions: output values are signed, so correct results are presented if current changes direction.
- Supports AC current measurement, RMS values are presented on output for AC current.
- Fast serial port response: less than 1 ms response time, can process more than 10 modbus transactions per second.
- Wide power supply range from 18 to 68 VDC.
- Low power: consumes 1,5 W.
- Built-in signal processing: 10 kHz sampling rate, 12 bit resolution on all channels, the board calculates average, maximum and minimum values. Min and Max values can capture very short current and voltage fluctuations.
- Isolated serial port makes the board more reliable, it will survive short circuits on measured power lines.
- Current sensors can measure current in high voltage conductors.
- Both integer and floating point values are available in separate sets on modbus registers.
- Calibration of sensors is supported in firmware. Additional calibration allows to compensate for zero offset and sensor errors.

Instalation and wiring

DC12 consists of two PCBs one on top of the other which are fixed together with four screws using 10 mm spacers. The bigger board is a two layer PCB, it carries the sensors. The smaller board is a four layer PCB, it carries power supply, DSP and comm port electronics.

Processor board has four LED indicator lamps which are described in table below.

For external connections the processor board has two connectors: four pole connector P5 and three pole connector P4.



The four pole connector P5 (upper connector)

P i n	F u n c t i o n
1	Power +48V
2	Voltage sense +(0..120V) DC
3	Power -48V
4	Voltage sense -(0..120V) DC

To connect power and measured input voltage use four external 0,5A fuses.

The three pole communications connector P4 (lower connector)

P i n	F u n c t i o n
1	RS 485 A (+)
2	RS 485 B (-)
3	RS 485 ground

All three pins are isolated from the rest of the board. The „ground“ pin is provided to terminate the comm cable shield. By connecting the shield to pin 3, the shield is not grounded, use separate ground wire if grounding of this end of shield is required. The communications bus shield should be grounded only on one place, see RS485 wiring rules.

Technical specifications

P o w e r s u p p l y	
Power supply range	18-60 VDC
Power consumption	1,5W
Protection	Built-in overvoltage protection (transil), upstream fuse 0,5A recommended
EMI	built-in LC filter
C u r r e n t m e a s u r e m e n t	
Number of channels	12
Range	-200..+200, -400..+400 or -800..+800A (depends on sensor type)
Max conductor size	external Ø 22 mm
Accuracy	1% of range
Numeric resolution	0,1% of range
Max overload	10x range
V o l t a g e m e a s u r e m e n t	
Number of channels	1
Range	0-120VDC
Accuracy	0,5% of range
Max overload	-200 VDC .. +200 VDC
Input impedance	99 kOhm
C o m m u n i c a t i o n s p o r t	
Physical interface	two wire RS485
Speed	9600 or 19200 bps, default setting is 19200 . Other port speeds are supported up to 115200 bps, but we recommend to use the default setting.
Port settings ¹	1 start bit, 8 bit data, even parity, 1 stop bit. These settings are recommended in modbus RTU protocol definition. Other settings are also supported.
Protocol	Modbus RTU according to V1.02 published in 2006

1 Port speed and settings can be configured, see configuration parameters. Default settings follow modbus RTU specification.

Reading the measurements

Modbus RTU protocol is used to read measured values. Two wire bus is used to connect multiple current meters or other modbus devices to modbus master.

Default settings of DC12 board are in compliance with newest modbus standard. Modbus protocol definitions and bus wiring rules are all well documented on www.modbus.org, so we are not duplicating this information in this manual.

For correct modbus operation it is essential to use correct shielded cable, to terminate the bus with terminating resistors. Please read modbus wiring rules on www.modbus.org.

Each communications bus must be equipped with at least one overvoltage protection device. If the bus is longer than 50 meters, we recommend to install overvoltage protection on both ends of the bus. One of manufactures of suitable overvoltage protection devices in Czech republic is Saltek s.r.o., device type is DM-006/1 R DJ.

According to recommended modbus wiring rules, communications bus must be earthed (connected to PE) strictly in one point. Important: pin 3 on DC12 communications port is named „RS485 ground“. This pin is NOT grounded, this pin is connected to isolated power supply „minus“ of the comm port. Comm port power supply is galvanically isolated from all other circuits of DC12 as well as from 48VDC power supply.

Measurements modes

„Mode“ parameter is used to select measurement modes. There are two modes:

- in DC mode voltage and current measurements are calculated as mean, max and min values from primary samples. Mean values are arithmetic mean calculated from circular buffer of samples. In DC mode, current values can be positive or negative.
- in AC mode, we first calculate RMS values from the circular sample buffer. Then min and max values are calculated from RMS values. In AC mode, all current values are always positive.

Supported data formats

DC12 supports three number formats: uint16, SINT16 and float32. Float32 is not exactly standard format for modbus, different variations of byte orders are possible and we support only one. So if our float32 is not readable correctly in your application, please use integer formats. All measurement information is available in both integer and floating point formats at the same time. To improve resolution, multipliers are used with integer values, multipliers are documented in table heading for each table.

Current average values (A), float32

A d d r	T y p e	D e s c r i p t i o n
40001	float32	I1 avg
40003	float32	I2 avg
40005	float32	I3 avg
40007	float32	I4 avg
40009	float32	I5 avg
40011	float32	I6 avg
40013	float32	I7 avg
40015	float32	I8 avg
40017	float32	I9 avg
40019	float32	I10 avg
40021	float32	I11 avg
40023	float32	I12 avg

Current maximum values (A), float32

Maximum values are automatically set to zero after each reading, so each time we get maximum values that occurred between polls.

A d d r	T y p e	D e s c r i p t i o n
40025	float32	I1 max
40027	float32	I2 max
40029	float32	I3 max
40031	float32	I4 max
40033	float32	I5 max
40035	float32	I6 max
40037	float32	I7 max
40039	float32	I8 max
40041	float32	I9 max
40043	float32	I10 max
40045	float32	I11 max
40047	float32	I12 max

Current minimum values (A), float32

After each reading, minimum values are set to average values, so each reading gives minimum values that occurred between polls.

A d d r	T y p e	D e s c r i p t i o n
40049	float32	I1 min
40051	float32	I2 min
40053	float32	I3 min
40055	float32	I4 min
40057	float32	I5 min
40059	float32	I6 min
40061	float32	I7 min
40063	float32	I8 min
40065	float32	I9 min
40067	float32	I10 min
40069	float32	I11 min
40071	float32	I12 min

Power average values (kW), float32

A d d r	T y p e	D e s c r i p t i o n
40073	float32	P1 avg
40075	float32	P2 avg
40077	float32	P3 avg
40079	float32	P4 avg
40081	float32	P5 avg
40083	float32	P6 avg
40085	float32	P7 avg
40087	float32	P8 avg
40089	float32	P9 avg
40091	float32	P10 avg
40093	float32	P11 avg
40095	float32	P12 avg

Voltage measurements (V), float32

A d d r	T y p e	D e s c r i p t i o n
40097	float32	V avg
40099	float32	V max
40101	float32	V min

Current average (A), SINT16 x10

A d d r	T y p e	D e s c r i p t i o n
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40201	SINT16	I1 avg
40202	SINT16	I2 avg
40203	SINT16	I3 avg
40204	SINT16	I4 avg
40205	SINT16	I5 avg
40206	SINT16	I6 avg
40207	SINT16	I7 avg
40208	SINT16	I8 avg
40209	SINT16	I9 avg
40210	SINT16	I10 avg
40211	SINT16	I11 avg
40212	SINT16	I12 avg

Current maximum values (A), SINT16 x10

Maximum values are automatically set to zero after each reading, so each time we get maximum values that occurred between polls.

A d d r	T y p e	D e s c r i p t i o n
40213	SINT16	I1 max
40214	SINT16	I2 max
40215	SINT16	I3 max
40216	SINT16	I4 max
40217	SINT16	I5 max
40218	SINT16	I6 max
40219	SINT16	I7 max
40220	SINT16	I8 max
40221	SINT16	I9 max
40222	SINT16	I10 max
40223	SINT16	I11 max
40224	SINT16	I12 max

Current minimum values (A), SINT16 x10

After each reading, minimum values are set to average values, so each reading gives minimum values that occurred between polls.

A d d r	T y p e	D e s c r i p t i o n
40225	SINT16	I1 min
40226	SINT16	I2 min
40227	SINT16	I3 min
40228	SINT16	I4 min
40229	SINT16	I5 min
40230	SINT16	I6 min
40231	SINT16	I7 min
40232	SINT16	I8 min
40233	SINT16	I9 min
40234	SINT16	I10 min
40235	SINT16	I11 min
40236	SINT16	I12 min

Power average values (kW), SINT16 x100

A d d r	T y p e	D e s c r i p t i o n
40237	SINT16	P1 avg
40238	SINT16	P2 avg
40239	SINT16	P3 avg
40240	SINT16	P4 avg
40241	SINT16	P5 avg
40242	SINT16	P6 avg
40243	SINT16	P7 avg
40244	SINT16	P8 avg
40245	SINT16	P9 avg
40246	SINT16	P10 avg
40247	SINT16	P11 avg
40248	SINT16	P12 avg

Voltage measurement (V), SINT16 x100

A d d r	T y p	P o p i s
40249	SINT16	V avg
40250	SINT16	V max
40251	SINT16	V min

Setup and calibration

Calibration is an advanced topic. In most cases users will not need no calibration, but in case you need calibration, make sure you call our support for further guidance.

Supported modbus commands for setup and calibration

Setup and calibration procedures support only a limited set of valid modbus commands. Generally, for distinct parameters like „port speed“ or „unit id“ (aka „bus address“), we only support „read single register“ and „write single register“ commands. So you have to set these values one by one.

For array parameters like current sensor ratings and for current sensor calibration, we only support „write multiple registers“ and „read multiple registers“ commands with starting address corresponding to the first sensor and with number of registers exactly 12. For example, if we want to set the range of all sensors on the board to 200, we have to issue „write multiple registers“ command with starting address of 40911 and number of registers 12. All other variations of write command will fail with modbus exception code 1 meaning „illegal function“.

Serial port settings

On start-up the processor always starts with default port settings and with address set to 0. After 10 seconds the port settings and address are changed to configured values stored in non-volatile flash memory.

In case we have no contact with DC12, we can connect just one board to the bus, switch ON the power supply and we have 10 seconds to read or change communications settings as required.

Calibration procedure

Calibration is optional procedure to improve measurement accuracy and eliminate possible zero offset of the current sensors. Without calibration DC12 measures to 1% accuracy which is enough for most applications.

Calibration is supported in software with two steps:

- Sensor offset calibration:
 1. Ensure there is no current flowing through sensors.
 2. Write the „magic number“ to specified register. Zero offsets for each sensor will be calculated and saved to non-volatile memory.
- Correction coefficient calibration:
 1. Run known current through sensor or multiple sensors. Be sure the current is big enough, at least 10% of sensor rating or more. Calibrating the sensors with small current will actually reduce the measurement accuracy.
 2. Program the value of this known or measured current in Amperes to write-only calibration register(s). The calibration coefficients will be

automatically calculated and stored to non-volatile memory.

Both offset values and calibration coefficients resulting from calibration are available in read only registers for documentation purposes, someone may want them to be printed on calibration protocol. Offset values are signed integer values in „A/D converter counts“, they are added to A/D conversion results to correct sensor offset. Default offset values are zero. Correction coefficients are floating point numbers used as multiplier when converting A/D result to Amperes. Default correction coefficients value is one.

Configuration parameters

A d d r	T y p e	D e s c r i p t i o n
40901	UINT16	Unit ID, address on the bus, range 1 to 254
40902	UINT16	Port speed, 9600 or 19200 (default)
40903	UINT16	0 = no parity, 1 = odd parity, 2 = even (default)
40904	UINT16	1 = one stop bit (default), 2 = two stop bits
40905	UINT16	Mode: 0 = DC (default), 1 = AC

Offset calibration

A d d r	T y p e	D e s c r i p t i o n
40906	UINT16	Magic number: writing the value of 7294 to this register triggers automatic offset calculation for all current sensors, offsets are then stored in non-volatile memory.
40907	UINT16	Magic number: writing the value of 1278 to this register triggers board reset to factory defaults.

Sensor ranges

DC12 can have three types of sensors installed, the part numbers are HTFS 200-P/SP2, HTFS 400-P/SP2 and HTFS 800-P/SP2. Current range of sensors is coded into part number. Theoretically, sensors with different ranges can be mounted on single DC12 board. So we can set the sensor range individually for each sensor.

A d d r	T y p e	D e s c r i p t i o n
40911	SINT16	Range 1 - range of sensor 1 (200, 400 or 800)
40912	SINT16	Range 2
40913	SINT16	Range 3
40914	SINT16	Range 4
40915	SINT16	Range 5
40916	SINT16	Range 6
40917	SINT16	Range 7
40918	SINT16	Range 8

A d d r	T y p e	D e s c r i p t i o n
40919	SINT16	Range 9
40920	SINT16	Range 10
40921	SINT16	Range 11
40922	SINT16	Range 12

Offsets (sensor reading deviation with zero current) (read only)

A d d r	T y p e	D e s c r i p t i o n
40923	SINT16	Offset 1
40924	SINT16	Offset 2
40925	SINT16	Offset 3
40926	SINT16	Offset 4
40927	SINT16	Offset 5
40928	SINT16	Offset 6
40929	SINT16	Offset 7
40930	SINT16	Offset 8
40931	SINT16	Offset 9
40932	SINT16	Offset 10
40933	SINT16	Offset 11
40934	SINT16	Offset 12

Correction coefficients (read only)

A d d r	T y p	P o p i s
40935	float32	K 1
40937	float32	K 2
40939	float32	K 3
40941	float32	K 4
40943	float32	K 5
40945	float32	K 6
40947	float32	K 7
40949	float32	K 8
40951	float32	K 9
40953	float32	K 10
40955	float32	K 11
40957	float32	K 12

Known current values for sensor calibration

Writing the known or measured current value in Amperes for each sensor calibration coefficients will be calculated and stored to non-volatile memory. These coefficients are used to calculate the measured current values.

<i>A d d r</i>	<i>T y p e</i>	<i>D e s c r i p t i o n</i>
40959	float32	I1 cal: measured current value for I1
40961	float32	I2 cal
40963	float32	I3 cal
40965	float32	I4 cal
40967	float32	I5 cal
40969	float32	I6 cal
40971	float32	I7 cal
40973	float32	I8 cal
40975	float32	I9 cal
40977	float32	I10 cal
40979	float32	I11 cal
40981	float32	I12 cal

Voltage calibration value (read only)

<i>A d d r</i>	<i>T y p e</i>	<i>D e s c r i p t i o n</i>
40983	float32	Kcal - correction coefficient for voltage measurement.

Known or measured voltage for calibration (write only)

<i>A d d r</i>	<i>T y p e</i>	<i>D e s c r i p t i o n</i>
40985	float32	Writing known voltage to this register will trigger Vcal calibration coefficient calculation. Result is then saved in non-volatile memory.

Package contents

The following contents should be found in your box:

- Main (bigger) board with sensors
- Processor (smaller) board with plastic cover
- User manual

