TR8-RS485-25A

Multi-channel DC voltage and current analyzer

1. DESCRIPTION OF THE UNIT

TR8-RS485 is a measurement unit with up to eight DC channels and a voltage channel, handling up to 1,000 Vdc. Current is measured through eight hall effect transformers (transformers used to measure DC current), with a 25 A primary.

The unit has two RS-485 communications ports. The first port is used to connect and transmit the information to the master with the Modbus/RTU protocol. The second communications port can be used for multi-master communication topologies (see section 4.6.- Connection diagram of the RS-485 communications slave and sub-slave), since many applications can be composed of a large number of TR8-RS485 analyzers. The communications parameters can be configured with the switches on the unit's front panel.

In addition, the unit has 8 digital inputs (logical) for the detection of the status of digital signals coming from the unit's environment. This information will also be available via RS-485 communications.

2. PRELIMINARY CONSIDERATIONS

2.1 Checks on reception

On receiving the instrument, check the following points:

- The unit's specifications are the same as those on your order.
- Check that the device has not suffered any damage during transport.

You can download further and updated information from the **CIRCUTOR** website: www.circutor.com

2.2 Safety precautions

The staff using or handling the unit must follow the common safety measures and warnings included in the instruction manual.

The **TR8-RS485 unit has been specifically designed for its installation in a control panel or enclosure fixed to a DIN rail. The equipment must never be installed or integrated in a place where people may have direct contact. TR8-RS485** has a flashing red LED (CPU) when it is in operation and, therefore, it shows that there is voltage and current in the electronic circuit. The user must make sure that the unit is not connected to the power supply at all times, even when the LED is not flashing.

3. INSTALLATION AND START-UP

The user must take into account and observe the information and warnings included in this manual to guarantee the correct operation of the unit and comply with the safety specifications. The unit must not be turned on until it is fully installed in the electrical panel.

IMPORTANT!

The unit's protection systems might not be effective if the unit is used for purposes other than those specified by the manufacturer.

Disconnect the unit from the power supply when the unit's safety protection systems are not working or there are signs of a problem (for example, in the case of visible damage). In this case, contact a qualified technical service or contact our Technical Assistance Service TAS (see section 7.- TECHNICAL ASSISTANCE SERVICE).

3.1 Installing the equipment

The unit will be installed on DIN rails. It has a surface for 9 DIN modules (157.5 mm) and a height of 58 mm. All connections remain inside the electric panel.

Remember that with the unit connected, the terminals may be hazardous to the touch, and opening the covers or removing elements may provide access to parts that are dangerous to the touch. The unit must not be used or powered until it is fully installed.

IMPORTANT!

DC power supply of TR8 must be protected by fuses, circuit-breaker or any other devices providing overcurrent protection. This devices must be set according to the DC installation power.

The unit must be connected to a power supply circuit protected with fuses. The fuses' specifications will comply with the power supply range and its consumption. Likewise, the power supply circuit must have a built-in circuit breaker or equivalent device to disconnect the unit from the power supply network. The power supply circuit must be connected with a cable that has a minimum section of 1 mm².

3.2 Power supply of the unit

The unit has two auxiliary power supply inputs; an AC and a DC current input. The user must not connect both power supply inputs at the same time.

Power supply	AC	DC
Nominal voltage	230 V~	24 V ⎓
Power supply tolerance	± 30 %	± 10 %
Frequency	50 Hz	-
Consumption of the equipment without transformers	2 VA	2 W
Consumption of the equipment with 8 sensors (no load)	9 VA	6 W
Consumption of the equipment with 8 sensors (with current)	13 VA	9 W
In-rush current	3.5 A (3 ms)	15 A (1 ms)

Operating conditions	
Operating temperature	-35...+65ºC
Relative humidity (non-condensing)	5... 95% RH
Maximum operating altitude	2,000 metres
Protection	IP 20

Precision			
Voltage measurement margin	30 ... 1000V	Current measurement margin (FS: 3.9V)	10 ... 100 %
Voltage measurement Error	1% FS	Current measurement Error	± 0.5 % FS
Resolution Error	± 0.075 % I_n	Offset Error	0.075 % I_n

Digital inputs			
Quantity	8	Impedance	12 MΩ

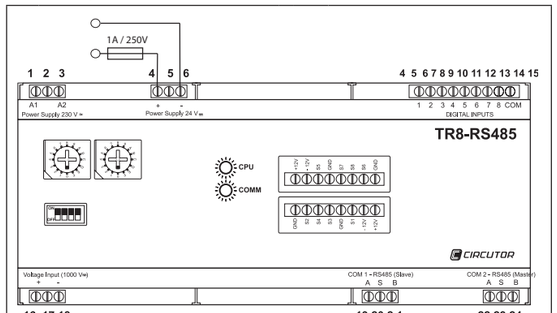
Safety

Category III – 300 V~
Voltage measurement: Category III - 1000V ⎓
Overcurrent internaly protected by high impedance
Double-insulated electric shock protection class II

CE UL

4. CONNECTIONS

4.1 Description of connection terminals



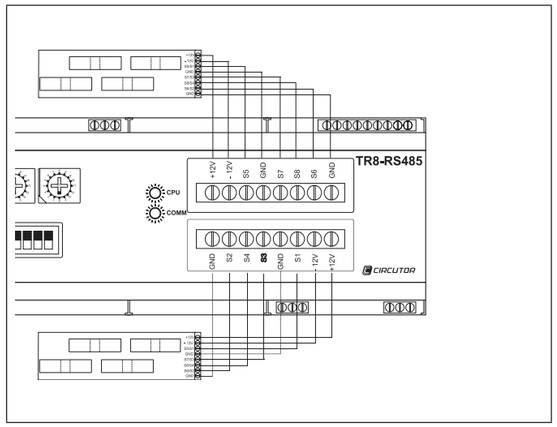
	Description		Description
1	Supply 230 V~	13	Digital Input 7
2	Not used	14	Digital Input 8
3	Supply 230 V~	15	Digital inputs common
4	Power supply 24 V ⎓ (+)	16	Continuous voltage (positive)
5	Not used	17	Not used
6	Power supply 24 V ⎓ (-)	18	Continuous voltage (negative)
7	Digital Input 1	19	Slave port (A - Positive)
8	Digital Input 2	20	Slave Port (S - GND)
9	Digital Input 3	21	Slave port (B - Negative)
10	Digital Input 4	22	Master port (A - Positive)
11	Digital Input 5	23	Master Port (S - GND)
12	Digital Input 6	24	Master port (B - Negative)

IMPORTANT!

When connecting a transformer that has not been specified by the manufacturer or with a primary current different to that specified in this manual, the voltage measurement will be incorrect and the unit's protection systems might not work properly.

4.2 Connection diagram of current transformers

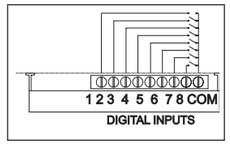
The **TR8-RS485** has been designed to measure up to 8 DC current lines simultaneously. The unit has eight built-in inputs for hall effect transformers, which can measure DC currents of up to 25 A per channel.



Connection details of M/TR8 transformers

4.3 Connection details of digital inputs

The **TR8-RS485** unit has eight voltage-free inputs and a voltage of 24 Vdc in the common for the detection of the logical status of external sensors. It reads the status of inputs in real time (open or closed contact) and transmits this information through the RS-485 communications bus.



The use and cabling of these inputs is optional and its execution does not affect the operation of the rest of the set.

4.4 Connection diagram of the conventional RS-485 communications bus

The **TR8-RS485** unit has a RS-485 communications port for real-time communications, with a master communications system of the PLC or SCADA type for industrial control purposes. Communications are through a braided pair communications cable with shielded mesh and a minimum of three wires. The system accepts a maximum distance of 1,200 metres between the master system and the last peripheral unit. A maximum of 32 peripherals can be connected in parallel to the communications bus for every port used.

In any case, star-shaped topologies must be avoided, thus linking the output of the communications bus of a peripheral to the next input and so forth. The installation of a resistor at the end of the line is not required for the installation of these devices. SEE LAYOUT A

4.5 Connection diagram of the RS-485 slave and sub-slave communications bus

The **TR8-RS485** unit has a second communications bus that is used to establish communications with other **TR8-RS485** units in parallel (sub-slave units).

The RS-485 communications bus has a limitation of 32 units per bus, so that each node connected to the main bus can communicate with 31 new units simultaneously. Therefore, a maximum of 32 units plus an additional 31 sub-slave units per node installed can be installed on the main bus.
This communication topology will be followed by the installation of many different nodes within a single communications network, with no penalty on the pooling of the main communications bus.
The header unit connected to the main network records all memory addresses of the sub-slave units connected to it, so that the communications master reduces the number of nodes queried throughout the communications bus and, therefore, reduces the pooling time.
The topology and connections are shown on LAYOUT B

5. CONFIGURATION

As regards the measurement of DC voltage or current, the unit does not require any sort of special configuration, since the internal adjustment and configuration ranges are already set up at the factory.

5.1 Communication

The communications protocol implemented is of the MODBUS/RTU® type.
The **TR8-RS485** peripheral unit is connected to a control system with the RS-485 bus, as shown on the connection diagrams. A node number will be assigned to each unit so that it can be identified within the communications bus.

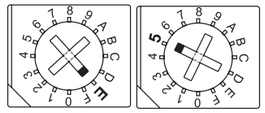
The front panel includes a series of built-in rotary switches and MINI-DIPS that can be used to establish the parameters of the different communications setpoints. Only the parameters of the node or peripheral number and the RS-485 communication speed must be established to integrate the unit in the bus. These will obviously be the same as those of the communications master.
The default configuration of communications is: 1 stop bit, Parity No and 8 bit length (8/N/1).

5.2 Configuration of the peripheral number

The two rotary switches on the unit's front panel can be used to establish the peripheral number (node). The unit communicates the peripheral or station number with the Modbus/RTU protocol, which will range from 1 to 255 (FF in hexadecimal). The configuration of the node is achieved with the said number in hexadecimal format. Decimal format must not be used. Examples of decimal to hexadecimal conversion:

Decimal Node	Hexadecimal Node	Decimal Node	Hexadecimal Node
10	0A	80	50
15	0F	150	96
25	19	180	B4
50	32	200	C8
65	41	255	FF

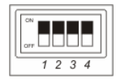
The first number corresponds to the left switch and the second one to the right switch in the case of hexadecimal node numbers. The unit does not have to be reset once the device number has been configured.



E5 = 229

5.3 Configuration of the communication speed

TR8-RS485 has a four-switch module (MINI-DIPS), that can be used to configure the transmission speed with switches 1 and 2. See the following table:



Transmission speed	Switch 1	Switch 2
9,600 / 8 / N / 1	OFF	OFF
19,200 / 8 / N / 1	OFF	ON
38,400 / 8 / N / 1	ON	OFF

The unit does not have to be reset when the transmission speed is modified. Likewise, it does not have to be changed when the node number is changed (peripheral).

5.4 Configuration of slave and sub-slave units

The user can use switch 3 to select the type of communications topology. The unit can be configured as a conventional slave in a communications network or it can be configured as a sub-slave within a multi-slave network.

5.4.1 Slave units

On LAYOUT A, the communications bus has a conventional communications topology. In this type of topology, the peripherals are numbered 1 to 255 (01 to FF in hexadecimal).

Switch 3 Position Layout A	OFF	The nodes are numbered 1 to 255 (01 to FF in hexadecimal).

5.4.2 Sub-slave units

In the case of communication systems with slaves and sub-slaves (LAYOUT B. Connection diagram of the RS-485 slave and sub-slave communications bus), the communications of the units marked as sub-slaves ($A1_2$, $A2_2$,.., $A32_2$ ... $A1_{32}$, $A2_{32}$,.., $A32_{32}$) must have a different configuration and a well ordered node numbering system.

The slave nodes (A_1, A_2 ... A_{32}), can be numbered from peripheral 1 to 255, as specified in the previous section (from 01 to FF in hexadecimal). On the contrary, the sub-slaves of each communication bus must be numbered 2 to 32 (02 to 20 in hexadecimal) and correlative to each corresponding bus. Slave units can not detect the presence of sub-slave units with node numbers above 32 (20 in hexadecimal).

Equipment	Switch 3	Decimal Node	
A1	ON	01	The nodes are numbered 1 to 255 (01 to FF in hexadecimal). The numbers can not be repeated and they do not have to be assigned in a logical or correlative order.
$A1_2$	OFF	02	The nodes will be numbered 2 to 32 (02 to 20 in hexadecimal) and the numbering must be correlative, with no node numbers unassigned.
...	OFF	--	
$A1_{32}$	OFF	32	

IMPORTANT!

The slave unit must be reset when adding new sub-slaves (bus header: A_1, A_2 ... A_{32}). For example, when you add device $A2_3$, the A_2 unit must be reset.

This operation is needed to make sure that the header scans the whole communications bus and implements all information coming from sub-slave units in its memory map.

5.5 Modbus Protocol

The **TR8-RS485** peripheral unit communicates with the MODBUS© protocol. Within the MODBUS© protocol, RTU mode (Remote Terminal Unit) is used; every 8-bit byte in a message contains two 4-bit hexadecimal characters.

The format of each byte in RTU mode:

Code	8 bits, binary, hexadecimal 0-9, A-F 2 hexadecimal characters contained in each 8-bit field of the message.
Bits per byte	8 data bits
Check-Error Field	CRC type (Cyclical Redundancy Check)

Modbus functions implemented:

Function 03 and 04	Function used to read the parameters measured by **TR8-RS485**. All electrical parameters are 16-bit words, so that a Word (2 bytes – XX XX) is required to request each parameter.

5.5.1 Modbus/RTU© Memory Map

This table shows the Modbus addresses of the conventional slave unit. The next tables (module 2 and subsequent) show the memory addresses of sub-slave units connected.

local variable	Abbreviation	Symbol	Address	Unit
Current 1	M1-MLC1	*I* 1	0000	Ax100
Current 2	M1-MLC2	*I* 2	0001	Ax100
Current 3	M1-MLC3	*I* 3	0002	Ax100
Current 4	M1-MLC4	*I* 4	0003	Ax100
Current 5	M1-MLC5	*I* 5	0004	Ax100
Current 6	M1-MLC6	*I* 6	0005	Ax100
Current 7	M1-MLC7	*I* 7	0006	Ax100
Current 8	M1-MLC8	*I* 8	0007	Ax100
Earth leakage voltage	M1-VDC	*Ud*	0008	Vx10
Digital inputs	M1-DIG		0009	
Peripheral No. (Lo)	M1-PERIPH		000A	

The following tables (sub-slave 2 and subsequent) show the initial addresses of the modules, taking into account that all have the same distribution in the bus header unit.

Module	Addresses	Module	Addresses
2	000B, up to 0015	18	00BB, up to 00C5
3	0016, up to 0020	19	00C6, up to 00D0
4	0021, up to 002B	20	00D1, up to 00DB
5	002C, up to 0036	21	00DC, up to 00E6
6	0037, up to 0041	22	00E7, up to 00F1
7	0042, up to 004C	23	00F2, up to 00FC
8	004D, up to 0057	24	00FD, up to 0107
9	0058, up to 0062	25	0108, up to 0112
10	0063, up to 006D	26	0113, up to 011D
11	006E, up to 0078	27	011E, up to 0128
12	0079, up to 0083	28	0129, up to 0133
13	0084, up to 008E	29	0134, up to 013E
14	008F, up to 0099	30	013F, up to 0149
15	009A, up to 00A4	31	014A, up to 0154
16	00A5, up to 00AF	32	0155, up to 015F
17	00B0, up to 00BA		

Examples of memory addresses of some of the sub-slave units, when they are connected.

Module 2	Address	UDS	Module 3	Address	UDS
M2-MLC1	000B	Ax100	M3-MLC1	0016	Ax100
M2-MLC2	000C	Ax100	M3-MLC2	0017	Ax100
M2-MLC3	000D	Ax100	M3-MLC3	0018	Ax100
M2-MLC4	000E	Ax100	M3-MLC4	0019	Ax100
M2-MLC5	000F	Ax100	M3-MLC5	001A	Ax100
M2-MLC6	0010	Ax100	M3-MLC6	001B	Ax100
M2-MLC7	0011	Ax100	M3-MLC7	001C	Ax100
M2-MLC8	0012	Ax100	M3-MLC8	001D	Ax100
M2-VDC	0013	Vx10	M3-VDC	001E	Vx10
M2-DIG	0014		M3-DIG	001F	
M2-PERIPH	0015		M3-PERIPH	0020	
...					

5.5.2 Reading the status of digital inputs (DIG)

The DIG variable, as in the rest of variables, is a record (1 word = 2 bytes), in other words, it would be 0xFFFF in hexadecimal format. Inputs range from I1 to I8 and each one represents a bit of the byte with the smallest size:

LARGEST BYTES								SMALLEST BYTES							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	I8	I7	I6	I5	I4	I3	I2	I1

For more information about the Modbus memory addresses, see section 05.05.01, Memory Map. The value of each input determines whether it is active (1) or inactive (0).

Example 1 (in master unit):

TX	NP 040009000F CRC	
Inputs activated	I3	
Per communication	INP=0x0004	Hexadecimal
	0000000000000100	Binary

Example 2 (in master unit):

TX	NP 040009000F CRC	
Inputs activated	12, 17 and 18	
Per communication	INP=0x00C2	Hexadecimal
	0000000011000010	Binary

5.5.3 Reading the peripheral number

The PERIPH variable, as in the rest of variables, is a record (1 word = 2 bytes), in other words, it would be 0xFFFF in hexadecimal format. This record describes the peripheral number on the unit's front panel associated to each slave and sub-slave device.

5.5.4 Number and list of sub-slave units connected

Number of sub-slave units: There is a Modbus registry that indicates the number of sub-slave units connected to the communications master (see LAYOUT B, units, A_2 ... A_{32}). This variable only returns the numerical value in hexadecimal, reporting the number of nodes connected to the device through the master communications port (in case it is used).

Example 1:

TX	NP 0408340001 CRC
RX	NP 0402 0006 CRC

Number of slaves	6	
Per communication	RX = 0x0006	Hexadecimal
Decimal conversion	6	Decimal

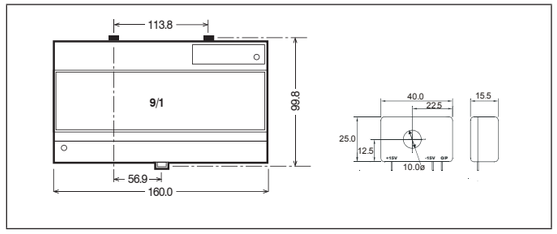
List of sub-slave units: The list of sub-slave elements connected to a unit reports the number of peripherals connected to the master unit one by one, unlike the case of standard numbers.

Example 1:

TX	NP 0407D0000F CRC
RX	NP 0420 02 03 04 05 06 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 CRC

List of slaves	02, 03, 04, 05, 06	Hexadecimal
Decimal conversion	02, 03, 04, 05, 06	Decimal

6. DIMENSIONS

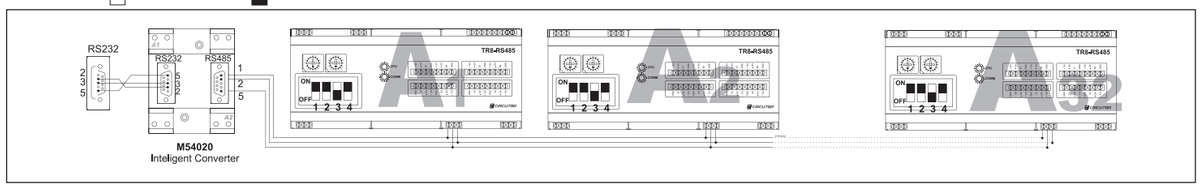


7. TECHNICAL ASSISTANCE SERVICE

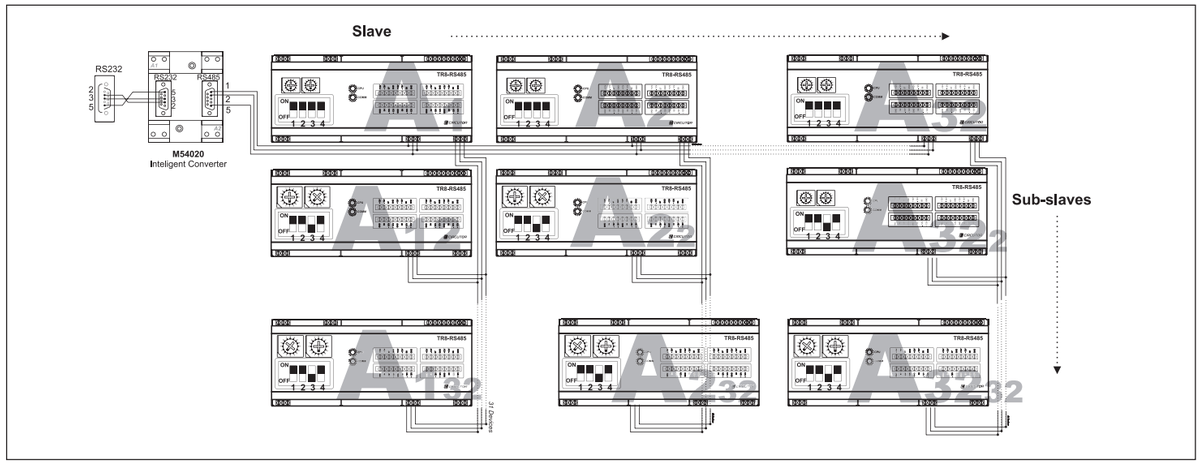
If you have any doubts about the running of the unit or any faults, contact the service staff of **CIRCUTOR, SA** at:

CIRCUTOR, SA - Technical Assistance Service
Vial Sant Jordi, s/n - 08232 Viladecavalls (Barcelona) SPAIN
Tel.: + 34 902 449 459 - Fax: + 34 93 745 29 14
email: central@circutor.es

SWITCH ON **SWITCH OFF**



LAYOUT A - Connection diagram of the RS-485 communications bus with slave units (conventional bus)



LAYOUT B - Connection diagram of the RS-485 communications bus with slave and sub-slave units